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# EDITORIAL

## FERTILISER RATIONING AND DISTRIBUTION

*Tea.*—Owing to lack of supplies it proved impossible to issue manure to tea estates during the first six months of the year. Shipments are, however, again being received and during the third quarter (July-September) tea estates will receive 25 per cent of their quota for the year. This is being issued in the form of T.280, the composition of which is as follows :—

T. 280.

| | Lb. | Nitrogen | Phosphoric Acid | Potash |
|---|---|---|---|---|
| Ammonium Sulphate ... | 125 | 25.75 | — | — |
| 7 per cent Organic Mixture ... | 60 | 4.20 | — | — |
| Saphos Phosphate ... | 85 | — | 25.07 | — |
| Muriate of Potash (60 per cent.) | 10 | — | — | 6 |
| | 280 | 29.95 | 25.07 | 6 |

280 lb. of this mixture therefore contain the same quantity of nitrogen as 500 lb. of T. 500 or 460 lb. of T. 460, the mixtures formerly in use. Rates of application should therefore be adjusted accordingly.

It is hoped to issue a further 25 per cent of tea quotas to estates in the last quarter of the year, but the date at which distribution will commence will depend on shipments. This issue will be in the form of T. 240, viz :—

T. 240.

| | Lb. | Nitrogen | Phosphoric Acid | Potash |
|---|---|---|---|---|
| Ammonium Nitrate ... | 80 | 25.50 | — | — |
| 7 per cent Organic Mixture ... | 65 | 4.55 | — | — |
| Saphos Phosphate ... | 85 | — | 25.07 | — |
| Muriate of Potash ... | 10 | — | — | 6 |
| | 240 | 30.15 | 25.07 | 6 |

As Ammonium Nitrate readily absorbs moisture, application of this mixture should not be delayed any longer than is essential.

*Rubber.*—Issues of rubber manure have continued normally throughout the year and estates will receive their full quota. No change will be made in the mixtures to be issued during the fourth quarter.

*Coconuts.*—Rationing does not apply and estates can order their usual requirements without permits.

ROLAND V. NORRIS.

# SHOT-HOLE BORER DAMAGE AND TEA YIELDS

C. H. GADD

E.M.N.

In a previous article the writer (Gadd 1943) asked the question : "Does manuring reduce the damage caused by Shot-hole borer ?" and presented data from a manurial experiment in the Passara district indicating that the answer was in the negative. The experiment there described was continued for a third year, and the data collected during that further period October, 1942 to September, 1943 are now presented for discussion. (Table 1.)

Manures were applied in March, 1943 at the same rate as previously.

sists of a main branch together with all the twiggy growth it carries. The first collection was made on January 31st, 1942, when the tea was 16 months old from last pruning. On that date 2,689 broken branches were collected from the whole experimental area (3.2 acres). Thereafter the broken branches were collected weekly for 83 weeks until September 2nd, 1943, when the experiment ceased at the end of a 3-year plucking cycle. Records of these collections are given in a simplified form as Fig. 1. In February, 1942, 4,821 broken branches were collected from the 3.2 acres

TABLE I

Yield and number of broken branches during the third year from pruning and for the whole cycle, from 3·2 acres

| Treatment | Yield in lb. | | Broken Branches | |
|---|---|---|---|---|
| | 3rd year | Total | 3rd year | Total |
| O | ... 226·36 | 658·64 | 1898 | 8,249 |
| N | ... 297·15 | 824·56 | 2,334 | 10,318 |
| P | ... 243·13 | 691·95 | 2,228 | 8,900 |
| NP | ... 283·84 | 734·04 | 2,203 | 10,611 |
| K | ... 301·32 | 841·60 | 2,697 | 11,364 |
| NK | ... 286·33 | 789·93 | 2,187 | 9,619 |
| PK | ... 210·67 | 626·23 | 1,910 | 8,425 |
| NPK | ... 270·44 | 753·81 | 2,317 | 9,528 |
| Total | 2,119·24 | 5,970·76 | 17,774 | 77,014 |

During the course of the experiment the damage caused by shot-hole borer was estimated by counting the number of branches broken in each plot after each pluck, *i.e.*, at weekly intervals. What is here termed a "broken branch" refers to that part of the woody frame which comes away when a branch is broken ; each con-

after four plucks in that month. By a simple calculation a value of 377 is obtained for the mean number of breakages per acre per week for the month of February, 1942. Other values were obtained similarly for the other months of the experiment and they are shown graphically in Fig. 1. It will be seen that the mean weekly number

of breakages increased steadily until June, 1942 when a peak, 765 breaks per acre was reached. Afterwards, the number of breakages decreased until March, 1943 and then remained fairly constant at a low level of about 80 breaks per acre per week until

Damage was at a maximum in June, 1942 (765 breaks per week per acre) and near a minimum in June, 1943 (82 breaks). Are we to interpret those observations to mean that shot-hole borer beetles were less numerous in the district in June, 1943 than in 1942? General observations give no

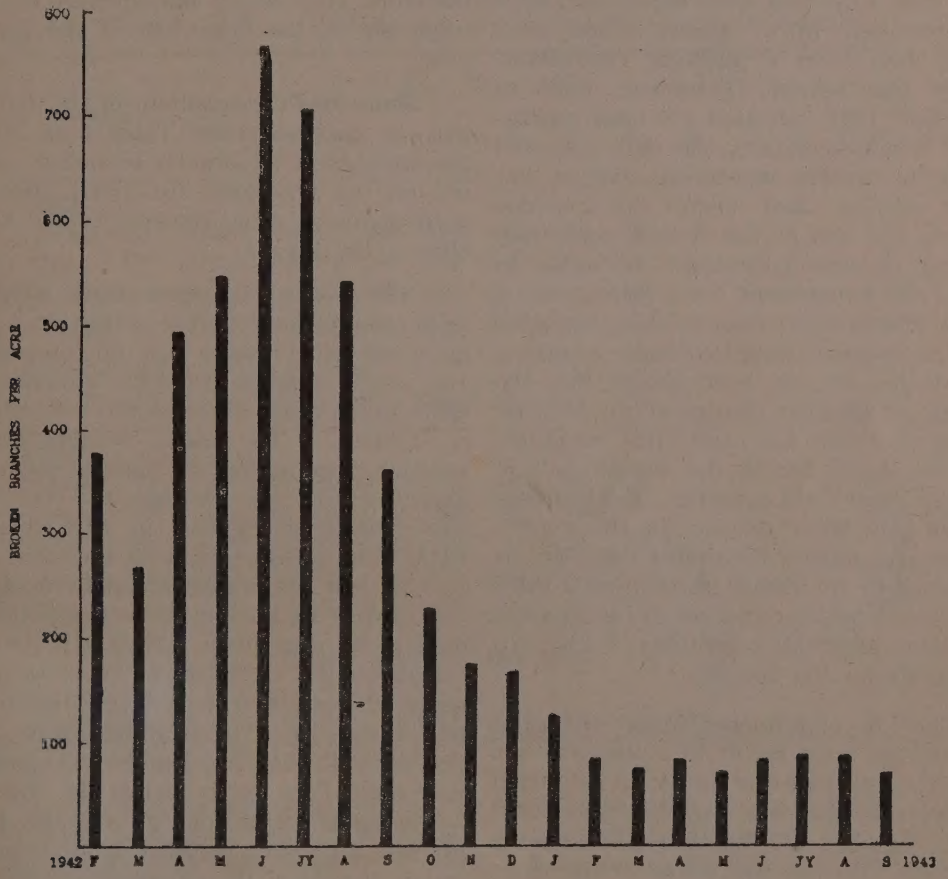


Fig. 1.—The mean number of broken branches per acre collected weekly, after plucking during the period February, 1942 to September, 1943. A three-year plucking cycle terminated in September, 1943.

he end of the experiment. The maximum amage therefore occurred during the econd year from pruning which ended in eptember, 1942.

support for such an interpretation, as throughout the district shot-hole borer damage in 1943 was much the same as in 1942.

The writer (Gadd 1941 pp. 135-137) first drew attention to the fact that shot-hole borer attack, although it may not cease entirely, is very materially reduced during the third year from pruning. His evidence was based largely upon an analysis of data collected by Jepson (Jepson and Gadd 1925) over a pruning cycle September, 1920 to November, 1923. Later, (Gadd 1942 p. 32) data from a plucking experiment during the period December, 1938 to December, 1941 indicated a similar conclusion. When, therefore, the data collected during the present experiment showed that insect damage had begun to decrease towards the end of the second year from pruning, it was considered advisable to extend the experiment for a third year, if for no other reason than to ascertain whether the decrease would continue as expected. It has already been shown that the amount of damage continued to decrease during the first half and then remained at a low level during the second half of the third year from pruning The decrease in shot-hole borer damage in the experimental area during 1943 must therefore be attributed to the bushes being in their third year from pruning ; and *not* to the weather or other external conditions being unfavourable for the beetles.

The loss of branches from tea bushes in plucking must result in a loss of crop, and although such loss cannot be estimated it is probable that it is roughly proportional to the number of branches lost through breakage. During the whole 3-year cycle 77,014 broken branches were collected and removed from the whole area. That number is equivalent to 24,067 per acre or 7.4 branches per bush. During the third year 17,774, (*i.e.*, 555 per acre) branches were broken as compared with 59.240, (*i.e.*, 1,851 per acre) previously, though mainly in the second year. Breakages in the third year were less than one-third of the number broken in the second year. During the last six months of the cycle, March to August, 1943, the mean number of broken branches per pluck per acre was 82 as compared with 558 during the same months of the previous year ; the loss in crop during the last six months of the cycle resulting from shot-hole borer attack was therefore only about one-seventh of that occurring in the later half of the second year.

Some idea of the extent of the damage may be obtained from Table 2 in which the weights of all broken branches collected on ten occasions are given, together with diameter measurements of the branches at the breaks.

The broken branches were weighed fresh, immediately after collection. In order that the results may be comparable the mean weights per 100 branches for each occasion are given in the last column of Table 2. The mean weights varied somewhat from time to time as might be expected ; on the average the branches were somewhat heavier in 1942 than in 1943. The average from all occasions was 5.27 lb. per 100 branches and by applying that value to all the branches collected during the experiment (77,014) it may be calculated that 1,268 lb. of branches were removed from each acre during the 3-year plucking cycle. The prunings from clean pruned bushes on St. Coombs (where shot-hole borer does not occur) at the end of a 3-year cycle weigh, on the average, 8,000 lb. per acre (dry weight) from which a rough picture of the extent of the damage may be visualised.

Diameter measurements of broken branches at the fracture were taken with a gauge. A branch which would not slip into the slot of the gauge 3-sixteenths-of-an-inch wide but would enter the next larger slot was recorded as 4-sixteenths ; its true diameter of course might be anything between 3 and 4 sixteenths-of-an-

inch. The necessary correction was therefore made when calculating the mean diameters given in Table 2. During 1943 the broken branches were but slightly thicker than in 1942 (0.25 in. as compared with 0.23 in.) This difference, though small, is probably real as the table shows that in 1942 the 3-sixteenth inch class was the largest, whereas in 1943 there were more branches in the 4 and 5-sixteenth inch classes than in the 3-sixteenth inch class.

TABLE 2

Weight and diameter at the fracture of broken branches on 10 occasions.

| Collection No. | Date | No. of Branches | Weight lb. | Mean diameter in sixteenths-of-an-inch. 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Mean diameter inches | Mean weight per 100 branches lb. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1942 | | | | | | | | | | | | |
| 1 | January 31 | 2,689* | 169·78 | 233 | 256 | 223 | 100 | 13 | 5 | 0 | 1 | 0·24 | 6·31 |
| 17 | May 22 | 1,722 | 90·74 | 777 | 536 | 313 | 84 | 12 | — | — | — | 0·21 | 5·27 |
| 32 | September 4 | 1,162 | 52·64 | 390 | 327 | 287 | 134 | 18 | 4 | 2 | — | 0·23 | 4·53 |
| 36 | October 2 | 643 | 31·92 | 188 | 191 | 160 | 87 | 16 | 1 | — | — | 0·24 | 4·96 |
| 40 | October 30 | 705 | 30·40 | 186 | 195 | 191 | 107 | 23 | 2 | 1 | — | 0·25 | 4·31 |
| | Total | 6,921 | 375·57 | 1,774 | 1,505 | 1,174 | 512 | 82 | 12 | 3 | 1 | 0·23 | 5·43 |
| | 1943 | | | | | | | | | | | | |
| 64 | April 13 | 257 | 11·22 | 28 | 52 | 90 | 68 | 18 | 1 | | | 0·28 | 4·37 |
| 70 | May 27 | 216 | 12·60 | 41 | 63 | 65 | 40 | 7 | — | | | 0·25 | 5·83 |
| 74 | June 25 | 260 | 9·71 | 56 | 116 | 61 | 23 | 4 | — | | | 0·23 | 3·73 |
| 78 | July 22 | 328 | 13·72 | 92 | 103 | 88 | 41 | 4 | — | | | 0·23 | 4·18 |
| 82 | August 19 | 258 | 11·78 | 38 | 81 | 80 | 50 | 9 | — | | | 0·26 | 4·57 |
| | Total | 1,319 | 59·03 | 255 | 415 | 384 | 222 | 42 | 1 | | | 0·25 | 4·48 |
| | Grand Total | 8,240 | 434·51 | 2,029 | 1,920 | 1,558 | 734 | 124 | 13 | 3 | 1 | 0·23 | 5·27 |

* The diameters of only 831 were measured.

On eight occasions, enumerated in Table 3 the broken branches were studied in greater detail. Every gallery was examined and classified as occupied or empty; the contents of the occupied galleries were counted. As all breakages had occurred at the sites of galleries, every broken branch had a gallery at the fracture. The percentages of such galleries as were occupied by beetles, pupae, larvae or eggs are given in Table 3. It will be seen that the percentage of occupied galleries fell from 10.9 in September, 1942 to 1.9 in April, 1943. This was a period during which the number of breakages in the plots was decreasing.

Before considering any possible connection between these two observations it must be pointed out that as the galleries under consideration were broken, it is possible that some of their contents were spilled at the time the branches broke. If all the contents of a gallery were spilled the gallery would then be counted as empty, and the percentage of occupied

galleries would in consequence be decreased. Such accidents may give false values for the percentage occupied but they are hardly likely to affect the trend of succes sive values. Galleries in the broken branches other than those situated at the fractures were opened to determine their contents. The results are shown in Table 3 under the heading 'Galleries in Branch.' Again it may be seen that the percentage of occupied galleries gradually decreased until May, but later increased again. The trend of these results follow fairly closely those obtained from galleries at the fracture though the actual values are higher. then be nil. The observed progressive fall in the percentage of occupied galleries to the low figure of 7.4 in the undamaged part of the branch must indicate a marked decrease in the number of new galleries being made. If so, the later rise in the percentage to 19.8 in July must indicate a renewal of the attack. This period of new invasion, April to July, 1943, corresponds roughly to the period of maximum attack in the previous year and so may be a seasonal effect. Judging from the number of breakages this late attack did relatively little damage.

TABLE 3

Galleries in Broken Branches

| Collection No. | Date | Galleries at the fractures. Total | Occupied | Occupied % | Galleries in Branch Total | Occupied | Occupied % | Mean Content | Galleries per 100 branches |
|---|---|---|---|---|---|---|---|---|---|
| | 1942 | | | | | | | | |
| 32 | September 4 | 1,162 | 127 | 10·9 | 10·16 | 278 | 27·4 | 2·3 | 87 |
| 36 | October 2 | 643 | 56 | 8·7 | 606 | 113 | 18·6 | 2·9 | 94 |
| 40 | October 30 | 705 | 43 | 6·1 | 595 | 104 | 17·5 | 2·8 | 84 |
| | 1943 | | | | | | | | |
| 64 | April 13 | 257 | 5 | 1·9 | 308 | 25 | 8·1 | 3·3 | 120 |
| 70 | May 27 | 216 | 23 | 10·6 | 121 | 9 | 7·4 | 1·0 | 56 |
| 74 | June 25 | 260 | 30 | 11·5 | 111 | 18 | 16·2 | 4·0 | 43 |
| 78 | July 22 | 328 | 40 | 12·2 | 175 | 35 | 19·8 | 2·5 | 53 |
| 82 | August 19 | 258 | 34 | 13·2 | 155 | 29 | 18·7 | 3·8 | 60 |

Do these observations lend any support to the statement made earlier, that the diminution in the number of broken branches after June, 1942 was due to cessation of attack by the beetles ? If attack ceased completely on a given date, no more new galleries would be made, but some of the existing galleries would contain beetles and their young. In the course of time these galleries would be vacated and eventually all would be empty. The percentage of occupied galleries would

The mean contents of the occupied galleries on eight occasions are also shown in Table 3. On May 27th, when the percentage of occupied galleries in the broken branches was at a minimum the mean content of the occupied galleries was 1.0. As the parent female remains in the gallery to tend the young the value 1.0 indicates that there were no young in any of the galleries examined at that time. That was the only occasion when neither eggs larvae nor pupae were found.

Individual galleries may contain as many as 30 or more young, but an average derived from a number of galleries chosen at random would never give a value as high as that. When studying the life history of the beetle it was found that galleries 36 to 49 days old, on the average, contained 12.6 young (Gadd 1941a); galleries younger than 36 days and older than 49 days had smaller mean contents. Galleries collected from the field are of very mixed ages and consequently vary greatly as regards their contents. At a time when galleries were increasing rapidly in number their mean contents (of 100 or more occupied galleries) ranged from 5.0 to 7.3 (Gadd 1942) and the writer is of the opinion that such values will be obtained only when conditions are favourable for the beetles. Under less favourable conditions the mean content of occupied galleries will tend to be lower.

The mean content of occupied galleries therefore depends upon two main factors (1) the mean age of the galleries and (2) the conditions within the gallery. It is impossible to ascertain the mean age of galleries collected at random from the field, so it may not be possible always to attribute a low mean content to the proper cause when the number of galleries examined is small. As in no instance do the values given in Table 3 exceed the value 4.0 it seems probable that the low values are indicative of somewhat unfavourable conditions in the galleries during the period September, 1942 to August, 1943.

The shot-hole borer beetles of tea spend practically the whole of their lives within galleries in living branches. In such a position they are well protected against enemies and against sudden changes of temperature and humidity brought about by the weather. It may not be obvious therefore why the beetles cannot breed equally well throughout the year in a tropical climate. What then are the unfavourable conditions referred to above ?

The beetle sometimes attacks a stem by boring a gallery and then vacates it before completion. This seems to happen most frequently when young stems are entered. Possibly the beetle finds the wood too sappy and the gallery too damp or the physical conditions unsatisfactory in other respects. The reason for the behaviour, however, is not known. When a gallery is completed satisfactorily the female plants a fungus (ambrosia) on its walls and her young later feed on the fungus. Much depends upon the growth of this fungus ; if the growth is poor the food supply may be short and the size of the family is reduced accordingly. The fungus gets its food from the tea bush and is in fact dependent on the bush for all its requirements. A small change in the life processes of the bush, resulting from any cause, may therefore affect materially the growth of the fungus and indirectly the size of the beetle brood. When large families are raised the numerous females, when adult, emerge and make many new galleries for themselves ; but when conditions are adverse the families are small ; few females emerge and few new galleries are found.

On this hypothesis it would appear that during the early part of the second year from pruning, conditions are at an optimum for the beetles, the population increases rapidly and numerous branches break in consequence. Later an adverse change sets in and the beetle population is gradually reduced but does not disappear entirely. The beetles are there, but in relatively small numbers ready to take advantage of any favourable change of conditions. This gross change from favourable to unfavourable conditions is gradual

and is undoubtedly associated with physiological and biochemical changes within the tea bush, possibly brought about by plucking. What those changes are cannot be defined at present but they probably react on the ambrosia fungus.

In the previous article in which the results of this experiment to the end of the second year from pruning were discussed, it was shown that the plots which gave the higher yields, in general suffered the greater damage from the boring beetles. This fact had not previously been demonstrated, so it may be well, before proceeding further, to ascertain whether the data collected during the third year demonstrates a similar correlation between yield and breakages.

In Fig. 2 are shown graphically the yields and number of broken branches collected from the different manurial plots during the third year from pruning. Each dot shows both the yield in lb. and the number of broken branches collected from four plots undergoing a particular manurial treatment indicated by a letter. The plots manured with potash alone (K) gave the highest yield, 301 lb., and the largest number of breakages, 842 (Table 1); they are represented by the dot K in the top right hand corner of the diagram. At the other extreme the plots receiving no manure (O) and phosphate and potash together (PK) gave the lowest yields and also the smallest numbers of breakages. The dots O and PK are in the bottom left hand corner of the diagram. A straight line has been drawn to pass as near as possible to all eight dots in the diagram. It starts near the bottom left hand corner, passes through a point representing the mean of all results (265 lb. and 746 breaks) and continues towards the top right hand corner. Other lines might be drawn by eye but they would all start near the bottom left corner and pass towards the top right corner. Such lines represent estimates of the effect of changes in one character (say yield) on the other (breakages). The line shown represents an increase by 62 breaks for every increase of 10 lb. in yield. The figure shows therefore that those plots which had the larger yields during the third year from pruning had also on the average the greater number of broken branches despite the fact that the general level of shot-hole borer attack had fallen considerably.

It will now be evident that the amount of damage occurring in a tea field as a result of shot-hole borer attack depends upon at least two factors: The first and more important is the age of the bush from pruning. The second is the degree of fertility of the field; its effect is relatively small as compared with the effect of age.

The fertility of an experimental plot is measured by the weight of crop harvested; the plot with the highest yield may be said to be the most fertile. Total fertility is made up of the initial fertility plus that added by way of manures. One of the problems in agricultural experimentation is to separate the effect of manuring from that resulting from initial fertility. Table 1 shows that 4 plots receiving potash manures only, yielded 301.32 lb. of tea during the third year, whereas 4 plots receiving no manure gave only 226.36 lb. The difference 74.96 is one estimate of the beneficial effect of potash manures on yield, but as shown in the previous article, 3 other estimates, equally valid, may be made. The truest picture is obtained by using all four estimates which brings every plot of the experiment into consideration. In this way the effects of nitrogen, phosphate and potash can be determined; such estimates are shown in Table 4, together with similar estimates of the manurial effects on breakages.

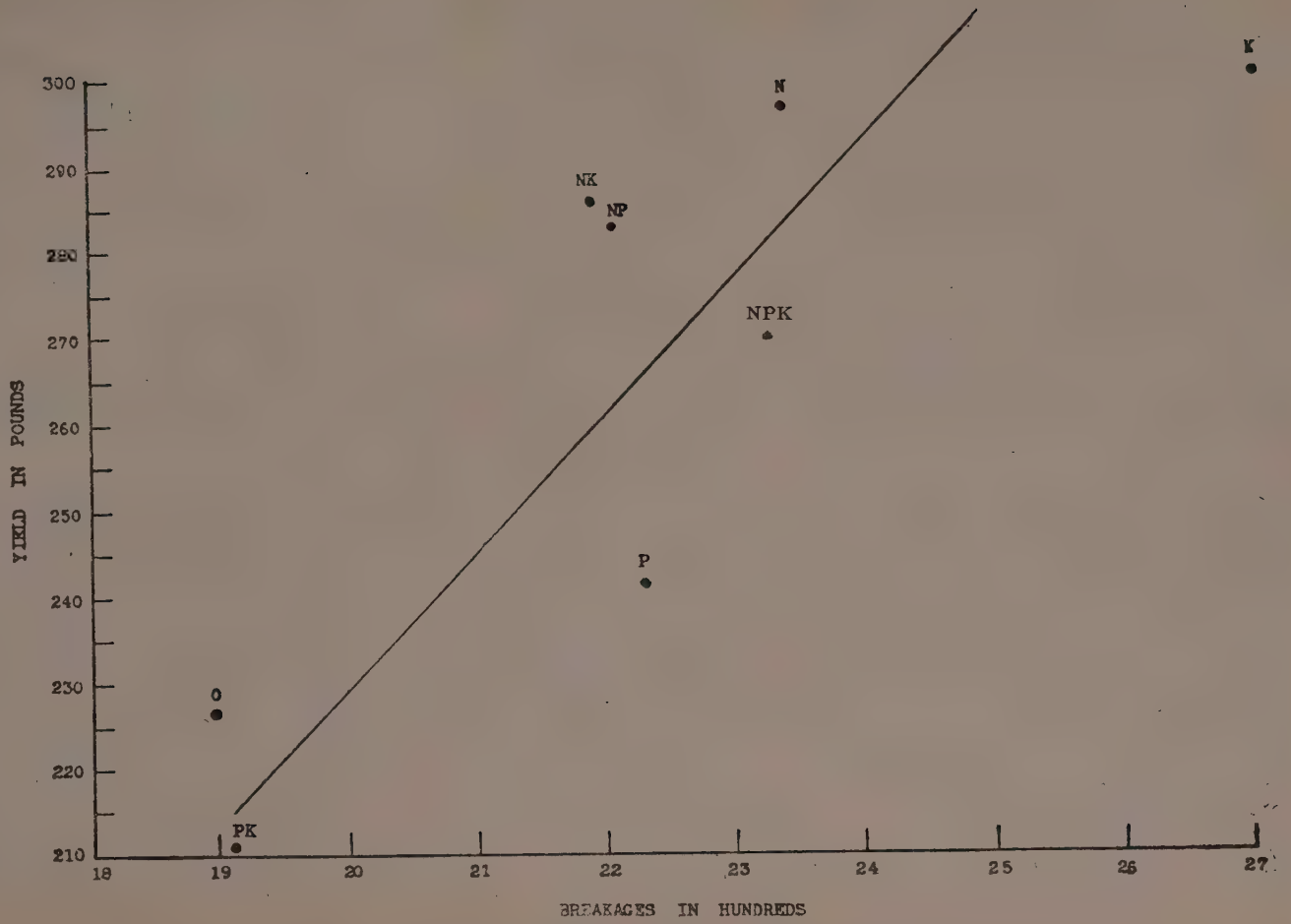


Fig. 2—Diagram showing the relationship between yield and number of broken branches during the third year of a plucking cycle.

Manurial experiments in areas free from shot-hole borer, such as St. Coombs, have always demonstrated a significant increase in crop as a result of nitrogenous manuring. In infested areas, such as the present experimental block, it has not been possible to demonstrate a similar response so clearly. In fact a significant response to nitrogen was demonstrated for the first time in this experimental block in 1943, during the third year of the cycle (Eden 1944). Incidentally this was the first time that this experimental area had been plucked over a 3-year period, previously the plots had been plucked on a 2-year cycle. The question naturally arises whether shot-hole borer was in any way responsible for the earlier failures to demonstrate a significant response from manuring. Although this question cannot be answered with any certainty it seems probable that shot-hole borer was at least in part responsible.

At the end of the second year from pruning the plots receiving nitrogenous manure gave 9.7 per cent more crop, but at the same time suffered 10 per cent more damage than the plots receiving no nitrogen. The increase in crop proved too small to be of statistical significance. As shot-hole borer damage leads to loss in crop it seems fair to assume that had the damage been equal in both series of plots the observed increase of yield in the manured plots would have been greater. In the third year from pruning the insect damage in all plots was considerably less than in the previous year and the N. manured plots suffered only 3.5 per cent more damage than those receiving no nitrogen. Yields were maintained at a relatively high level and there was an increase of 15.9 per cent in the plots receiving nitrogen as compared with those receiving none. This larger increase proved to be of statistical significance. It seems probable therefore that the reduced amount of borer damage, both total and relative to the plots without nitrogen enabled a significant increase in yield to be demonstrated.

TABLE 4

Effect of Nitrogenous Phosphate and Potash Manures on the Yield and Damage caused by Shot-hole borer during the third year from pruning. Each result relates to 1·6 acres.

| | Yield in lb. | | | % | Broken Branches | | | % |
|---|---|---|---|---|---|---|---|---|
| | With | Without | Increase | Increase | With | Without | Increase | Increase |
| Nitrogen | 1,137·76 | 981·48 | 156·28 | 15·9 | 9,041 | 8,733 | 308 | 3·5 |
| Phosphate | 1,008·08 | 1,111·16 | –103·08 | –9·3 | 8,658 | 9,116 | -458 | -5·0 |
| Potash | 1,068·76 | 1,050·48 | 18·28 | 1·7 | 9,111 | 8,663 | 448 | 5·2 |

A significant response in yield to nitrogenous manures was the only one expected. It may be seen from Table 4 that potash gave a small but statistically insignificant increase in yield and also in insect damage. Phosphates appear to have decreased borer attack slightly but they also depressed the yield somewhat. It is evident therefore that manuring has not proved of any value in controlling shot-hole borer attack. Any increase in crop following manuring has been accompanied by an increase in borer damage. Only when yield was depressed was there any decrease in borer damage

The effect of manuring on borer damage is very small compared with the effect of the bush's age from pruning. At the end of the second year breakages during plucking are numerous so it is to be expected that if the bushes are pruned then, breaks during pruning will also be numerous. During the third year the beetle attack falls to a low level, few new galleries are made and consequently breakages during plucking are few. Undoubtedly the bushes benefit from the improved conditions and less damage is to be expected from pruning. The question arises whether the extension of the pruning cycle in shot-hole borer areas is sound economically.

The prolongation of a pruning cycle is usually decided upon after consideration of factors other than the mere prevalence of shot-hole borer. Each case has to be considered on its own merits and the question may well be asked "Did the prolongation of the pruning cycle in this instance prove to be economically sound?" That question can be answered definitely from an examination of the yields. During the first two years (actually 25 months) the yield from the whole experimental area was 3,852 lb. or say an average of 1,926 lb. per year. In the third year (11 months) the yield was 2,119 lb. which exceeds the average for the first two years by 193 lb., *i.e.*, by 60 lb. per acre. Obviously, an increased yield was obtained as a result of the prolongation of the pruning cycle in this instance, but it must not be assumed that similar benefits will accrue in all cases. These results suggest that the prolongation of the plucking cycle beyond two years may be advantageous in some shot-hole borer infested areas.

## ACKNOWLEDGMENTS

The experiment was designed and laid out originally by Dr. T. Eden as a manurial experiment. I am indebted to him for allowing the entomological investigation to be superimposed on his experiment and for prolonging the pruning cycle. Messrs. G. D. Austin and W. T. Fonseka collected the field data and carried out the dissections of galleries.

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# PLANT VIRUSES AND VIRUS DISEASES

T. E. T. BOND

Disease in plants, as in animals, can be due to a variety of causes and in tea there are as many types of disease as in most other plants. A primary distinction is between those which are due chiefly to faulty environment and are *non-infectious* and those which are associated with the presence of a parasitic fungus or other organism and which are to a greater or less degree *infectious* or *contagious*. Of the former group, the "bitten-off" disease of tea seedlings is a good example. This disease, as Gadd [3] has shown, is due to adverse soil conditions, usually either excessive alkalinity or waterlogging. The actual destruction of the taproot to produce the "bitten-off" symptom is doubtless the work of micro-organisms which are favoured by these conditions in the soil, but, nevertheless, we are justified in regarding the disease as of primarily physiological origin. It is not infectious, and affected seedlings, if removed in time and transplanted to well-drained acid soil, will produce new roots and will grow into perfectly healthy plants. The various nutritional deficiency diseases, some of which were dealt with in the previous volume of *The Tea Quarterly* [1] are an even better illustration of this type of disorder, where the cure may consist in a simple application of fertiliser containing the deficient element. The *infectious* diseases are well represented in tea and most planters are only too familiar with at least some of them—*Poria* root disease, *Cercosporella* leaf spot, eelworm, and *"Phloem necrosis"* are representative examples. In all of these, infectiousness implies an infective agency which can pass from one plant to another and the science of plant pathology had its origin in the study of these disease-producing agencies. Usually, they proved to be distinct and easily recognisable organisms having a separate existence and life-cycle of their own but obtaining their food materials directly or indirectly from the infected host plant. The great majority of them were found to be parasitic fungi, but many other groups of living organisms (of which eelworms and bacteria are the most important) are known to be capable of producing disease in higher plants. In all of these instances the disease is diagnosed not so much from its external symptoms as from the occurrence of the causal organism within or upon the tissue of the host. But, beginning from the end of last century, and to an ever-increasing extent during recent years, a new class of infectious disease has emerged for which no visible causal organism can be detected, even under the highest powers of the microscope. That is not to say that these diseases are less conspicuous in their effects, or are less easy to recognise from their external symptoms than any others : in fact, the reverse is very often the case and their symptoms can be of a quite startling nature. This new type of disease is the *virus disease* and before attempting any further definition of a *virus* it will be well to have a clearer idea of the diseases themselves.

## THE PLANT VIRUS DISEASES

Accepting the position that virus diseases are infectious disorders for which no visible causal agency exists, it follows that for their recognition we are dependent, in the first instance at least, solely upon the symptoms produced in the host plant. There are two principal categories of plant virus diseases — the "mosaic" group, and the "yellows" group.

The first group, of the "mosaic" diseases, is so named because the most characteristic symptom produced on the various hosts is a mottling or mosaic of pale green, yellow, or white areas intermingled with areas of normal, darker green colour. Many of the "variegated" foliage plants commonly grown in mid-and low-country gardens show symptoms of this kind and in some cases, but not all, the variegation may be due to a virus disease. In other plants the mottling is much less pronounced, but may be accompanied by varying degrees of distortion of the foliage. In Ceylon, "mosaic" diseases are commonly seen up-country on ornamental tobaccos (*Nicotiana* spp.) and on French and Kidney beans.

The "yellows" group is perhaps rather less easy to define as a whole than the "mosaic" group. As the name implies, the whole plant may be yellowed, or *chlorotic*, but this is not universally the case. Distortion, or at least modification of the plant's normal habit and appearance, occurs quite commonly, and many of the names of individual diseases refer to this as the most typical symptom. Thus, in Ceylon, the "bunchy-top" of plantains belongs to this group and, in India, the "spike" disease of sandalwood. Another common symptom is a rolling or curling of the leaves of affected plants: thus we have the potato "leaf-roll" disease and "curly-top" of sugar beet. In all probability, *"Phloem necrosis"* of tea in Ceylon will be found to belong to the "yellows" group of virus diseases, and it will be remembered that one of the most characteristic external symptoms of *"Phloem necrosis"* is the dwarfed appearance of the shoots, with the leaves curled backwards and the stems prominently zig-zagged. Another Ceylon disease of this type is the tobacco leaf-curl, and there is evidence [4] that the same virus is also responsible for the striking symptoms commonly seen on the goat-weed *Ageratum conizoides*, ("Pum-pillu," Tamil). Here there is little distortion but a "yellow vein-banding," a clear yellow network following the fine veins. At first sight, this might be mistaken for an intense form of mosaic disease, but the restriction of the symptoms to the immediate vicinity of the veins is a characteristic of the yellows group of diseases.

Despite the occasional resemblance of their symptoms, the "mosaic" and the "yellows" groups of viruses appear to be, biologically speaking, fairly distinct. The two groups, for instance, show important differences in their natural mode of transmission and spread and these will be referred to later. Other types of virus diseases exist which afford a whole range of symptoms — severe distortion, modification of floral into vegetative organs, "witches brooms," etc. — and which show various modes of transmission. They need not be given any separate consideration here.

The economic importance of plant virus diseases would be difficult to estimate: all kinds of crops are affected in all countries of the world and the number of such virus diseases appears to be steadily increasing. Probably, nearly 150 distinct plant viruses have been described. The best illustration of the importance of virus diseases in one of the world's basic food crops is that of the potato industry. All growers at home are aware that potato varieties quickly degenerate if grown for more than a year or two from home-saved "seed" and that for good results Scotch "seed" potatoes must be imported each year. This degeneration is due entirely to a whole complex of virus diseases affecting the potato which, under ordinary conditions of cultivation, cause an increasing loss of vigour in the affected stocks. These diseases, upon the relative freedom from which in upland, wind-swept districts, the Scotch "seed" potato trade depends, have been estimated to cause a loss to the industry as a whole of some £2,000,000 annually.

## THE VIRUS: LIVING OR NON-LIVING

So far, the virus itself has been considered only as an invisible agency of disease — rather a negative qualification which is, in fact, all that can be said of a great many viruses: they are recognised as such only because all the other possibilities have been eliminated. Many other viruses, however, particularly those causing diseases of the "mosaic" type, are a great deal better known and, in fact, the study of such viruses has proved to be of great theoretical interest in the discussion of such fundamental issues as the distinction between living and non-living matter

Viruses are studied in *extracts* from infected plant tissues, that is, in the juice or sap expressed from diseased plants, which can be submitted to various methods of purification and chemical treatment. The earliest, and in some ways most fundamental discovery concerning the nature of the virus extract, was that it could be passed through a bacteria-proof filter and still remain infective, hence the term "filterable viruses" which is still frequently used for the group as a whole. While some workers have held that the virus was actually a liquid substance, it is now realised that it is essentially "particulate" in nature, and further experiments have enabled the size and shape of the virus particles to be estimated with a fair degree of accuracy. Some of the particles appear to be spherical, others are rod-shaped. The term "filterable" is now known to be relative only and it appears that some virus particles can be held back by special filters and are consequently not so very different in size from the smallest known bacteria after all. On the other hand, the smallest known virus particles are so incredibly small that they are of the same order of magnitude as the largest known *single molecules*. Bacteria are small enough, but what are we to make of these?

Another striking property of certain virus extracts is their resistance to antiseptics and other forms of chemical treatment, and to heat. The virus will remain infective, in many cases, long after any ordinary bacterium would be killed. Similarly, certain viruses can withstand long periods of drying, and storage under various conditions. One thing that no virus appears capable of doing away from the host plant is to multiply, whether in the crude virus extract or in specially prepared food media known to permit the growth of bacteria or other micro-organisms. Many viruses will stand very high degrees of dilution — for example, an extract of the tobacco mosaic virus is still infective at a dilution of one in a million — yet even so it can be demonstrated that no multiplication of the virus particles has occurred to counteract the effect of the dilution.

In all these ways we have seen the virus in the virus extract — that is away from the host plant — behaving much more like an inert but powerful chemical substance than a living micro-organism. Yet within the host plant, there is a strong suggestion that the virus is actually alive. For if a drop of highly diluted virus extract (perhaps so dilute that it contains only a few individual virus particles) is used to inoculate a healthy seedling plant of a susceptible variety, that plant will begin to show symptoms of infection within some few days and may eventually grow into a large plant which is diseased in all its parts. From this plant others may be infected, and the process may be continued indefinitely, and yet from any plant in the series a virus extract may be obtained of full strength and identical in its properties with the original, undiluted extract. Here is incontrovertible evidence of multiplication, and of multiplication true to type, in a manner which all our experience leads us to regard as characteristic of living matter.

The evidence in favour of the chemical nature of viruses was finally confirmed by

the recent discovery that some viruses at least could be obtained in a pure state and actually crystallised. These virus crystals have been shown to be of a complex protein nature and and they exhibit all the properties of the virus : there is now no question but that the virus is really obtainable in this chemically pure form. We are still faced with the question, how does this virus protein reproduce itself so efficiently within the living cells of the host. The answer, if we knew it, would take us a long step forward into that fascinating region of cell physiology which holds the secret of the nature and origin of life itself.

## HOW VIRUS DISEASES ARE SPREAD

From what has already been stated of the properties of certain virus extracts — particularly their resistance to ageing and dilution —, and of the rapid multiplication of viruses in their hosts, it will not be surprising to find that virus diseases can be extremely infectious, probably more so than most other types of disease. One of the simplest ways in which virus diseases are spread is by mechanical contact. This applies especially to the "mosaic" group from which infective virus extracts are most easily obtainable. Mechanical contact does not necessarily imply a direct transfer of the virus from a diseased plant to an adjacent healthy one although this frequently happens when the plants are growing so that their branches or leaves are touching. More frequently the contact is effected indirectly, as for instance by the transfer of infected sap on the hands or on knives or similar implements. A better description of this type of transfer would be "sap inoculation." If tea were ever to become subject to a virus disease of this kind, the disease would quickly be spread by pluckers and pruners and it is fortunate that, so far as we can tell at present, *"Phloem necrosis"* is not capable of transmission by sap inoculation. The extreme ease with which certain mosaic diseases can be transmitted by sap inoculation is illustrated in a striking manner by some diseases which affect both tobacco and tomato plants. These viruses are so resistant to heat and desiccation that they can survive the curing process of the tobacco leaf and remain infective in the manufactured product. Thus, the viruses can be obtained from most brands of cigarette, and, in commercial tomato cultivation, stringent precautions are necessary to prevent outbreaks of disease through contact with smokers. In American tobacco fields, mosaic diseases can similarly be spread from chewing tobacco.

Perhaps the most certain way of transmitting a virus disease from a diseased to a healthy plant is by grafting, although this is scarcely likely to happen as a regular occurrence in nature. As an experimental method it is invaluable, since it applies to all types of virus disease including some for which no other means of transmission has yet been found. This is the position at present with regard to *"Phloem necrosis"* for example. The graft normally consists of two components, the *stock* which is growing on its own roots, and the *scion* which is grafted on to it. Either component may be diseased, the other, healthy at the time of grafting, becomes diseased later as the virus passes across the graft union.

In nature, the commonest means of spread of virus diseases is through the agency of insects. The insects concerned are said to be *vectors* of the virus or viruses. The insect vectors do not appear to be themselves diseased ; they seem to act merely as passive carriers of the virus within their bodies. The position is not quite analogous to the transmission of malaria by the Anopheles mosquito, because in the latter case there is an undoubted organism, the malarial parasite, which is known to pass through certain stages of its normal life-cycle in the body of the insect. With the virus there seems to be some kind of biological relationship with the insect, but of this very little is known. The chief, almost the only,

insects which transmit plant viruses are the sucking bugs of which the aphids — "green-" and "black-fly" — are the best known examples. Some of these insects will transmit a single virus only, others are known to transmit a dozen or more. The insect feeds on plant sap which it obtains by means of its delicate, syringe-like proboscis. This is inserted into the plant tissues and saliva is pumped down it : the saliva mingles with the sap and the resultant mixture is then sucked up again into the body. Thus the feeding mechanism of the insect allows it to obtain the virus from infected sap, and to inoculate it again into the tissues together with the saliva. Factors which contribute to the efficiency of insect transmission, especially in the case of "yellows" viruses which are not readily transmitted by mechanical means, are that the virus never comes into contact with the air ; it is obtained with the minimum of injury to the plant and is again introduced into the plant in direct contact with the living cells. On the other hand for the insect to transmit a virus from a diseased to healthy plant, it has to feed for a certain minimum period in each case and usually a so-called "incubation" period has to elapse before the insect becomes infective. The motility of the insect, and its feeding habits generally, will obviously be of prime importance in determining the extent to which it will spread the infection. One interesting feature of the vector relationship is that in some cases the insect appears to differentiate between two viruses, both of which are associated with a given disease. Thus, it may happen that both the viruses are transmissible by sap inoculation but that only one of them is transmitted by the insect, so that different symptoms will be produced on healthy plants according to the method of transmission, and the virus complex can thus be resolved. Many other varied and complicated situations arise in working with insect vectors of virus diseases and there are many problems still to be solved.

## PREVENTION AND CONTROL

Virus diseases are usually not transmitted through the seed (the common bean mosaic is an exception to this) so with annual crops that are raised from seed one can at least start with healthy stock. Many of the most important virus diseases, however, occur in crops that are propagated vegetatively or that are perennial, occupying the same ground for many years at a time. The potato is an example of a perennial crop which is raised anew each year : consequently, the use of Scotch seed potatoes as healthy stcok is reasonably effective provided that this stock is renewed every year or so. Where the crop remains in the ground for many years at a time, as it does in the case of all woody plants like fruit trees and tea, the use of clean stock to start with would confer very little benefit unless protective measures could be relied on in the later stages. In practice, this is very rarely the case, since complete control of insect vectors would be necessary and this is impossible for plants in the field. It follows that virus diseases are of great importance for perennial crops and especially for those that are raised by vegetative means. Once the source of planting material becomes infected, virus will be present in all the progeny raised from cuttings, offshoots, budding, etc. and the crop as a whole may be faced with virtual extinction. Examples of the spread of virus diseases in this way are to be found in the growing of raspberries and of strawberries at the present time.

Fortunately, however, the control of virus diseases has not proved to be quite so impossible as might be concluded from the preceding paragraph. Most crops which are subject to virus diseases have been found to show considerable differences in susceptibility among their several

varieties. These differences are revealed in various ways. For instance, many plants will react differently to virus infection according to the climate in which they are grown and it is quite common for the symptoms of virus disease to be much less noticeable at relatively higher temperatures. Thus, infection may take place and produce severe symptoms in the spring and the disease may almost disappear in the summer, to become more severe again in the autumn. With *"Phloem necrosis"* of tea, for example, it is possible that the relative severity of the disease in the Nuwara Eliya and Kandapola districts compared with, for instance, Talawakelle, may be due largely to the higher altitude and lower average temperature of the former. Again, it happens in some crop varieties that the relative or complete absence of symptoms of infection by a virus may become permanent, so that in the latter case it would normally be impossible to tell whether a plant was infected or not. Such plants, which contain a virus without showing any symptoms of disease, are known as "carriers" and with *"Phloem necrosis"* it has recently been shown [2] that the apparent absence of the disease in *high jat* supplies may, in fact, be due to this cause. In tea, the use of "carrier" varieties will quite likely prove to be of value in eliminating the effects of *"Phloem necrosis,"* but it is easy to see that there are dangers inherent in this procedure and, in some crops, "carriers" are regarded with suspicion as hidden sources of infection to other healthy plants.

Finally, the plant's reaction to the virus may take the form of an inability to become infected at all, and this condition, which is described as resistance or *immunity*, is the most desirable of all. We do not know yet whether it exists in tea, but in crops as diverse as sugar-cane, strawberries, and cotton, resistant varieties have been obtained by selection or by breeding and a very effective measure of control of virus diseases has become possible. It seems likely that the best hope for the future lies in work of this sort, which is being actively pursued in many countries.

## CONCLUSION

In the foregoing, a selection only of the many interesting aspects of the study of plant virus diseases has been possible. The importance of these diseases for world agriculture needs no emphasis and for the study of biology as a whole they are also of great theoretical significance. No review of the plant viruses would be complete without mention of their relationship to the viruses which affect man and animals : small-pox,influenza, rabies, foot-and-mouth-disease — all of these and many others are caused by viruses which have various features in common with those affecting plants. Those who wish for further information on the subject of virus diseases as as a whole should read Smith's [5] recent book — "The Virus : Life's Enemy" : the title is probably not without justification.

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# THE COLLECTION AND USE OF STATISTICS

T. EDEN

"In pre-war days the average citizen's attitude towards Statistics was that of one of O. Henry's characters who defined it as 'the lowest grade of information known to exist.' A good many Civil Servants shared this view and a man with a statistical reputation in the Service was not always *persona grata* with the Higher Administration — at best he was considered a harmless drudge, at worst a nuisance who was apt to produce figures at the wrong moment to weaken a promising line of argument."

This quotation occurs in a Memorandum on Official Statistics, prepared by the Royal Statistical Society,* which describes the place held by statistics in the past and at present in official circles, and the place they may come to hold in the Post-War world.

To the ordinary man statistics are often incomprehensible and are associated with the ever-recurring annoyance of form-filling. Whether any use is ever made of them he is usually quite unaware. The war, though it has increased the number of returns that are demanded, has shown him that statistics have certain uses, and in this country he is probably acutely aware of how much better off we should have been if, for instance, there had been an adequate census of agricultural production on which to base our wartime food economy. He cannot help but be aware of the statistical basis of the Cost of Living Index, and, though he does not understand by what means it is calculated, he has not been slow to realise some of the defects of the methods by which it was originally prepared.

It may therefore be of general interest to consider the place of statistics in the present workaday world and the Royal Statistical Society's Memorandum is a lucid and much needed document on which to build a wider understanding of what statistics are about.

The memorandum starts by distinguishing between two sorts of statistics, the 'descriptive' and the 'mathematical' kind. The former is mainly concerned with the collection of data and their tabulation ; and very frequently the matter ends there. If one peruses the Ceylon Blue Book one finds a maximum of tabulated information and a minimum of interpretation.

Mathematical statistics go much further. They have a definite theoretical basis and also a very practical use. Frequently when information on a subject is desired it is impossible for reasons of time, personnel and the volume of work involved, to cover the whole ground. Recourse has to be had to the selection of a relatively small sample from which to draw conclusions applicable to a much wider sphere. In these circumstances it is of fundamental importance that the sample should be representative, and 'mathematical' statistics are used to determine whether the sample is of sufficient representativeness to be used as a reasonable basis for interpretation. Readers of this journal are familiar with two examples of this type of work. The Cost of Living Index is based on a family budget drawn up from a sample of families and on a sample of changing prices. It has been, and still remains, an outstanding defect of the Cost of Living Index that no attempt has been made to test the samples to see if they are really representative and reliable. The second illustration bears on the work of this Institute. The trial of cultural and manurial methods is carried out by means of experimental plots. These plots are

* Journal of the Royal Statistical Society, 1943, Vol. 106, pp. 145-166

samples of the wider conditions obtaining on estates as a whole, and the results are subjected to a rigorous mathematical statistical process to ensure that the apparent results are not due to chance or to faulty choice of local environment.

As the Memorandum points out there is no antagonism between the two types of statistical practice : they supplement one another and their practitioners differ as do those in the medical profession which has its general practitioners and specialists who work hand in hand.

The Memorandum points out that before the war, few, if any, of the 'statisticians' who compiled the statistics of the multifarious government departments had any training for their jobs. The work was turned over to personnel who were recruited for other purposes and on other qualifications. Some of them nevertheless became accomplished statisticians, but on the whole the work was of a distinctly amateurish nature. Each department worked in its own watertight compartment, and not only was much information lost because its existence went unrecognised, but there was no uniformity in the plan under which the data were collected, and no realisation that statistics collected by one department were, or might be, of interest and importance to another. Nor was there any thought that statistics were anything but an end in themselves. They were a summarised statement of a state of affairs at a given time which was the final result of legislative action or social conditions. On this point the memorandum says : "Perhaps we can put the point most clearly if somewhat broadly in this way : the work of statistical branches was to answer questions not to ask them. They were to provide numerical facts required for predetermined purposes, not to extract from these facts evidence of problems involved, or desirable lines of enquiry unpursued."

In England the war has changed all this. Food, Supply and Transport have made large-scale statistical enquiries vitally necessary as indicators of new policy, and everyone with the slightest pretensions to statistical knowledge, in and out of the services has been pressed into the work. The Society foresees that the need for trained statisticians will not end with hostilities, and it has suggested a scheme to meet Post-War requirements.

The first point in the scheme is that the collection of the primary data will continue to be the responsibility of the department that needs the data in the first place. The officers of the several departments are already in contact with the material, human or otherwise, that forms the basis of the enquiry. For example, in this country, the collection of data about malarial incidence would naturally fall within the province of the District Medical Officers. They would know much more about secondary factors, such as general stamina or debility of the population in a particular area. They would in all probability need help in determining sampling units and so on, and this would involve co-operation with a statistician who was fully alive to the difficulties and limitations of sampling. Similarly in the sphere of agricultural production, the agricultural officer would be the collector of the fundamental information. Secondly, the memorandum recommends that the statistical work of a department should be carried out by someone who is seconded for that purpose alone, so that there shall be continuity in work and administration. Such a scheme would imply that statistics would not be the Cinderella of a department, and that the officer who was deputed to organise or work in the statistical section should not be handicapped in promotion.

Some departments would not have enough work to justify a definite statistical section, and the memorandum provides for them. There should be a central statistical office staffed mainly by specialists. These officers would not undertake routine work,

but would advise, co-ordinate and generally supervise the departmental activities, and, in case of need, lend personnel to the smaller departments. In this way all government departments would work to the same desirable standards of accuracy, and the statistics of one department would dovetail into those of another. The whole statistical work of the country would be carried out under a system of freedom combined with co-operation and co-ordination. As the memorandum points out, existing statistical branches may not be conscious when advice or guidance is necessary, and there is a danger that help may not be called in until it is too late. A central statistical office would minimise this risk and would act as a research and educational body.

In this country official statistics of all sorts are in a very undeveloped stage, and the utility of mathematical statistics has not been realised. Plans are in hand, according to press communiques, to start statistical divisions for Labour, Medical Services and Agriculture. There is also a more ambitious scheme involving statistical officers (perhaps their proper designation would be computers) in all Kachcheries in connection with a production survey. In addition, a census is anticipated in 1946. Such promised activity is both encouraging and formidable. The need for a central statistical office, such as is recommended by the Royal Statistical Society, and is actually in existence in England on a temporary basis, is plain. Statistical compilations and computations are valueless unless the primary data are both accurate and in a form that satisfies the statistician's postulates. It is part of a statistician's job to trace inaccuracies and anomalies; to decide whether any data must be rejected, and to formulate definite grounds as a guide to such rejection.

It would be a great pity if time, effort and money were wasted on gathering and collecting information for lack of expert guidance at all stages of the enquiry from the design of the forms to be filled in to the final interpretation of the results. The general public will need education to make them statistically-minded, so that they will be conscientious co-operators. Nothing would so contribute to this desirable end as a conviction that adequately co-ordinated technical direction was the basis of the Government's plans.

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# SEEDLINGS AND CUTTINGS

JESSIE BOND

This note is intended to consider briefly the theoretical aspects of vegetative propagation of tea as compared with propagation from seed.

In any old tea field in Ceylon considerable variation is exhibited amongst bushes and from a small area of, say, forty bushes it is generally possible to pick out at least ten distinct types. Even in later plantings of high jat bushes, presumably from selected seed, variation remains, although not to so marked a degree. This variation is a result of the bushes having been grown from seed; although that seed may all have come from the same seed garden, or even from the same seed-bearer, there being no such thing at present as a "pure line" of tea, the seedlings vary amongst themselves.

The question is often asked whether, if a tea seed-bearer were self-pollinated, the resulting seed would give plants which would all be identical with each other and with the parent plant. The answer

is "No." With most annual crops, for example, peas, "pure lines" have been evolved. A named variety of garden pea seed, from a reputable firm, will give pea plants which are identical. If no pollen from other peas is allowed to come near those plants seed can be obtained, generation after generation in the ordinary way, and that variety will remain the same. But in woody plants of complicated hybrid origin, of which tea is an example, these "pure lines" have not been obtained, largely because their evolution would take at least fifty and probably over a hundred years. Thus every tea bush contains many "hidden" characters inherited from ancestors but not exhibited by the bush itself. These characters are liable to turn up again in some of the progeny. We arrive then at the conclusion that until "pure lines" are evolved tea seed will inevitably give a mixed population of bushes.

With vegetative propagation the position is entirely different. Tea can be propagated vegetatively from single node cuttings, the axillary bud of the cutting growing out to form the new bush. If that bud had been left on the mother bush it would, conditions being favourable, have grown out to form a branch. Thus the rooted cutting may be looked upon, not as a new individual, but merely as a detached branch of the original bush, and it will not vary from the parent, in its genetical constitution, any more than that branch, if it had been allowed to remain attached, would have varied. Of course, if the cutting is planted in very poor soil and the mother bush is in very good soil a difference in vigour, probably shown by leaf size and internode length, will be apparent but that is entirely a matter of the conditions of growth—"nurture" not "nature." Probably the most striking thing about the St. Coombs Clonal Plot in which each row is a separate clone, (*i.e.*, the vegetative progeny from a single mother bush) is the complete similarity of all the bushes in the row. After the usual heterogenous mixture that similarity is apparent to the most casual observer.

By vegetative propagation it is possible to exercise much greater control over planting material than by the use of seedlings. The chances of getting good bushes from the seed from a good seed garden may be high, but in the present state of our knowledge it is impossible to say to what extent these bushes will vary amongst themselves. On the other hand once a clone has been established as a good clone it can be multiplied indefinitely by vegetative means and, in the ordinary way, all these progeny will be identical. But just as vegetative propagation ensures that, constitutionally, the progeny are as good as the mother bush, it also limits them to being no better than the mother bush. So in propagating tea vegetatively we are not attempting to improve the type but to select and multiply the best existing bushes.

# NOTES ON GROWING INDIAN CORN INTERPLANTED IN OLD TEA AFTER PRUNING*

F. C. CHARNAUD

*Land.*—For preference choose an easy lie of land — not too steep and without too much permanent shade. Existing green manure trees should be lopped just before planting.

*Time of Pruning Tea.*—Pruning should take place 2 to 4 months before I. C. is put out, according to elevation. At Luckyland, at an elevation of 4,500 feet the I. C. will be planted in a field pruned between the 1st and 31st July. In the Welimada district, 3,500 to 4,000 feet, a fortnight later.

*Time of Planting.*—The I. C. seed should be put out the day after the first good N. E. shower of rain about the end of September or early October. It is not advisable to plant before the 15th September, with an early N. E. as the corn will be ripe sometime in January and if the N. E. continues to end January, as it often does, the ripe corn will be damaged. Late planting, say after the 15th October, may clash with a rush of leaf, when labour and factory accommodation are not available.

The same time of pruning and planting should meet conditions on the South West side of the Island.

*Preparation of the Land.*—The I. C. should be planted in alternate lines of tea. The opposite line to the one the prunings are usually stacked or buried in should be prepared. The whole acreage to be ready by 15th September.

*Holing.*—Mamoty holes to be cut in advance of the planting season. Round holes, about 12 inches in diameter at top and rounded off to a centre depth of about 10 inches are sufficient. The holes should be spaced 2 feet apart from centres of holes and as much as possible in the middle of the tea line.

A fair task for holing is 400 to 500 holes for a name, depending on the tilth of the soil, lie of land, weather conditions, stones, etc. In tea planted 3½ ft. × 4 ft. the I. C. holes should work out at about 2,700 to the acre.

*Manuring.*—Except on very rich soils, in the hollows, most lands will require manuring. The best is well-rotted cattle manure, next I prefer 6 to 8 months old line refuse, and failing these two, ordinary compost with the addition of some tea refuse.

Cattle manure may be applied at the rate of 1 lb. per hole (1¼ ton per acre), line refuse and compost 2 lbs. per hole, to be placed into each hole before filling in commences. A little soil from silt-pits, and drains, or jungle soil if handy, help the crop tremendously and are of benefit to the tea as well.

With the aforesaid treatment and the return to the land of the compost derived from the I. C. stocks after harvesting, there is no need to fear any evil effect to the tea crop. On the contrary, it may well increase.

In a good interplanted area which had yielded 20 bushels per acre, the out-turn of ripe compost made from the stocks and leaves, with the addition of a little sun flower and cattle manure worked out at an average of 3 tons per tea acre.

* The Institute does not necessarily endorse the views expressed in papers contributed by persons other than members of the Staff.

*Filling-in.*—After the placing of cattle manure or compost, etc., at the bottom of the hole, sufficient soil is added and *mixed* to fill the hole not quite to the top so as to leave a depression something like the shape of a dinner plate. This will give the plants a better anchorage and, together with the earthing up, prevent them from falling down later on when they are liable to become top heavy. The land is then ready for planting.

*Preparation of I. C. Seed.*—Obtain the proper variety of seed. There are a number of different kinds but I have found that the best is a type originally obtained from Bintenne and, from this during the past two seasons, a specially selected yellow variety has been propagated giving a more uniform growth of plant, cob and colour of corn and, I believe, higher yield.

I can book a few orders now, of this specially selected yellow variety at cents 30 per lb. of dry cobs.

78 to 80 lbs. of cobs will go to the bushel. Approximately 1,800 seeds go to the cut measure and as my recommendation is to plant 3 seeds per hole it follows that 4½ to 5 measures are required to plant one tea acre of 2,700 holes.

The seed should be soaked in water for a few hours the day before planting out and, in the evening, remove it from the water and place it, spread thinly, about one inch thick, between two wet sacks — don't let it soak in water all night.

Just before planting out, in the morning, mix half a cigarette tin of kerosene oil to one bucket-ful of wet seed. The mixing must be thoroughly well done. The smell of the kerosene oil protects the seed against attacks by lizards, birds and white ants before it has time to germinate. It does no harm if applied a few hours before planting. Better results could be obtained if the seed is sifted so as to eliminate the small undersized seeds.

*Planting.*—This is quite simple and goes very quickly. Plant 3 seeds to a hole in a triangle, about 3 inches apart. Each seed to be pushed about one inch into the the loose wet soil, holding the seed with the thumb and forefinger and covering it over with a stroke or two of the palm.

*Earthing-Up.*—When the plants are about 2 feet high the soil round about should be piled up round them into a mound about 10 to 12 inches high. This gives the plants a better anchorage and also provides the secondary roots which spring up, after a time, from the first and second joint of the cane, an added source of nurishment. If heavy rainfalls are experienced this earthing-up may have to be repeated at a later stage.

*Supports.*—On exposed places or where growth is luxurious it may be necessary to support the points with sticks 3 or 4 feet high or even to tie loosely together the two or three separate plants growing in one point. If earthing-up has been properly done this supporting will only be necessary for a small percentage of the plants.

*Protection from Pests and Thieves.*—The enemies of I. C. are stray cattle from an early stage. Then monkeys, squirrels, crows, parrots, parrakeets and, if the locality is near uncultivated land, wild boar. There is nothing for it but to have watchmen with guns. A 30-acre block will require one watchman at night and possibly two in the daytime.

It is, however, surprising how quickly all these pests, especially monkeys, crows and wild boar, will disappear and not return when they find out that the crop is being watched.

A few notices placed in the outskirts of the plantation warning people that the watchmen at night have instruction to shoot at anything moving in the corn has a very salutary effect on intending thieves. These precautions, are, of course, only necessary during the last month when the corn is ripening and during the few days of harvesting.

*Harvesting.*—Compared to other food crops, the gathering of the cobs, drying, and thrashing the corn is a simple and clean operation, requiring only a fraction of the labour. The crop should not be harvested until 95 per cent of the sheaths enclosing the cobs have turned yellow or are dry. If dry weather is prevailing, it is just as well to let them dry longer on the plants but a few days' rain at this stage may damage a percentage of the crop by turning the tips of the cobs mouldy and, in extreme cases, some of the corn will start germinating.

When gathering, the sheaths should be left on the plants. The reason for this is that three operations are done in one, *i.e.*, the corn is collected, the sheath is removed and it is left on the stock to increase the compost which will be made later.

Every labourer is provided with a pointed stick (like a pencil). The point is inserted at the top of the cob through the sheaths and drawn upwards thus cutting them in two. These two ends are then taken, one each, in the right and left hand and drawn apart thus exposing the clean cob which is broken off at the base and thrown into small heaps to be gathered by another gang.

In dry weather and with the sheaths quite dry on the day of harvesting, 100 lb. of cobs will eventually give one bushel. After drying for some weeks in the sun or by artificial means in the lofts of a tea factory, 76 to 82 lbs. of cobs will give one bushel depending on the degree of dryness.

*Drying.*—When large quantities are involved, say 300 to 1,000 bushels, it is not possible, and the weather cannot be depended on, to dry the cobs in the open but if one loft of the tea factory, preferably the top one, is lent to the food production effort for about 3 weeks the process of drying the cobs before storing them is simplified. This drying space is really what limits the acreage to be planted. 500 bushels or 50,000 lb. of cobs can easily be dried in a loft with a floor area of 5,000 sq. ft. The bottom two hessian tats should be temporarily removed thus facilitating the spreading and turning over of the corn. The cobs are then spread about a foot deep and turned over every other day. The withering fans, when not wanted for tea manufacture can be turned on to this loft.

In two or three weeks the corn should be quite dry and ready for storing. I have found that, if it is stored on the cob, no attacks by weevils need be feared. It can be put into bags and stored in a dry place from where monthly requirements can be taken for shelling.

*Shelling.*—This is a simple matter and all Tamil labourers know how to do it. Two women can shell 12 bushels in one day.

*Costs.*—Approximate costs are as follows :—

| | | |
|---|---|---|
| Holing per acre | ... | 6 labourers |
| Manuring & transport | | 8 ,, |
| Filling-in | ... | 6 ,, |
| Planting | ... | 3 ,, |
| Earthing-up | ... | 6 ,, |
| Supports | ... | 3 ,, |
| Watchmen | ... | 4 ,, |
| Harvesting | ... | 8 ,, |
| Drying | ... | 3 ,, |
| Shelling | ... | 3 ,, |
| Total | ... | 50 labourers |

| | | |
|---|---|---|
| Say at a Check-Roll average of Re. 1 | ... | Rs. 50.00 |
| Add to this cost of manure or compost | ... | „ 15.00 |
| Add to this cost of seed | ... | „ 5.00 |
| Add to this cost of transport | | „ 5.00 |
| Add to this cost of cartridges | ... | „ 50 |
| Total cost per acre | ... | Rs. 75.50 |

*General Remarks.*—If the I. C. is planted too soon after the pruning of the tea the quicker growth and shade of the corn will do the tea a lot of harm. The I. C. should be planted in tea a month before tipping.

A field of 22 acres planted in Indian corn on 1st September, 1942 yielded for the 12 months of 1942, *698* lbs. tea per acre. In 1943, *1,211* lbs. tea per acre.

Yields of the same field for previous cycle of pruning were :—

1938 ... 586 lbs. tea per acre
1939 ... 1,109 „ „ „ „

I attribute the increase in yields to the effect of the compost and manure applied to the Indian corn.

The above 22 acres yielded 432 bushels of corn. The area planted in 1943, 30 acres, gave 650 bushels or over 21 bushels per acre.

# REPLANTING TEA*

M. C. EVANS

In 1938 the writer had occasion to examine, in theory, the respective merits of supplying in old tea compared with eradication and replanting.—(*Tea Quarterly* Vol. XI, Part II, June, 1938).

Since that time actual replanting has been undertaken, and it is now possible to give some indication of experience gained in actual practice, in the hope that this information will be of interest.

To present any useful balance sheet it is necessary to know :—

1. The crops harvested from the area before replanting.
2. The actual cost of replanting and any connected expenditure, other than that which would have been expended had the original tea remained.
3. Crops harvested after replanting.

## CROPS HARVESTED BEFORE REPLANTING

The areas selected for replanting, three in number, formed each a part of three separate fields. By comparing the total yield of the field before and after the plot was replanted, it is obviously possible to arrive at a reasonably accurate figure representing the yield of the replanted area.

Averages for eight years prior to 1939, and also averages for the four years succeeding 1939 have been worked out and the figures are as follows :—

| | | |
|---|---|---|
| No. 1 Field — 38 acres. Average crop for 8 years | | 20,173 lb. made tea |
| „ 1 „ — 32 „ less 6 acres uprooted, average for 4 years | | 19,624 „ „ |
| Presumed crop for 6 acres | | 549 „ „ |

* The Institute does not necessarily endorse the opinions expressed in papers contributed by persons other than members of the Staff

Crops for the remaining two plots were calculated in the same manner, and the total crop for the whole replanted area of 26 acres came out as follows:—

| | | |
|---|---|---|
| No. 1 Field — | 6 acres | 549 lb. made tea per annum. |
| „ 2 „ — | 10 „ | 1,037 „ „ „ |
| „ 3 „ — | 10 „ | 968 „ „ „ |
| | 26 acres | 2,554 lb. „ „ |

or an average of 98 lb. made tea per acre per annum.

During the period under review, yields per acre for the total tea area averaged for the first 8 years 526 lb. per acre ; during the next four years, however, the average rose to 625 lb. per acre, owing to lifting of the Export Control etc :—

Thus for a reasonably true comparison the yield per acre of the replanted plots prior to replanting should be increased by 625, or say 25, to offset the increased pro- 526 21
ductivity of the estate after the plots were replanted.

This raises the figure of 98 lb. per acre to 98 × 25 or 116 lb. per acre.
21

So much for past performance.

## 2. COST OR REPLANTING

When examining costs in 1938 in theory, for the purpose of comparison between the two methods, supplying and replanting, it was assumed that every plant planted was successfully established.

In practice, of course, this is often far from the case, and the actual cost of replanting has been considerably higher than anticipated owing to the necessity of continued supplying in the clearings after droughts experienced in 1940 and 1941.

Under the same conditions, of course, an extensive programme of supplying in old tea would have met with similar difficulty.

The areas selected were replanted on the contour, the spacing of the plants being 1½ ft. × 5 ft., that is, the contours were approximately 5 feet apart and the plants 18 ins. apart in the row. This method is designed to produce eventually a hedge of tea along the contour which successfully creates its own terrace on steep land and thus goes a long way towards solving the problem of erosion, whilst the stand of tea, approximately 6,000 plants per acre, ensures a good yield.

Various cover crops were established between the contours whilst the young plants were growing, and eventually Vigna was found to be satisfactory, for it holds up the soil well, and is not too difficult to control or eradicate when the time comes.

Careful records of costs of all expenditure incurred over the 26 acres replanted have been kept, and from 1939—1943, excluding expenditure on manuring, weeding, forking, draining, etc., etc., all of which would have been incurred if the old tea had remained, a total of Rs. 8,564.41 has been expended over the four years as follows :—

| | | | | |
|---|---|---|---|---|
| Rooting out tea and forking out roots | Rs. 1,536.41 | or | Rs. 59.09 | per acre |
| Forking contours for planting ... | „ 351.75 | „ | „ 13.53 | „ |
| Purchase of tea seed ... | „ 2,425.80 | „ | „ 93.30 | „ |
| Nursery work ... ... | „ 409.63 | „ | „ 15.76 | „ |
| Pegs and Lining ... ... | „ 212.22 | „ | „ 8.16 | „ |
| Planting, supplying and shading ... | „ 1,862.43 | „ | „ 71.63 | „ |
| Watering ... ... | „ 631.48 | „ | „ 24.29 | „ |
| Planting, control and eradication of green manures (Boga, Crotalaria, Sword Plant, Sunflower and Vigna) | „ 1,134.69 | „ | „ 43.64 | „ |
| | Rs. 8,564.41 | or | Rs. 329.40 | „ |

Labour was charged at an average of 58.58 cents per day over the period and these figures are, of course, exclusive of Dearness Allowance.

When checking the cost of the routine works *other* than replanting on the 26 acres, this was found to be some Rs. 29 per acre more expensive than the average expenditure per acre per annum of the remainder of the mature tea area. This is probably due to the fact that two manure applications per annum were made to the clearings, and weeding costs were slightly higher owing to lack of shade. This being so, this expenditure is presumably a legitimate charge upon replanting and the replanting costs must be enhanced by Rs. 29 × 4 years or Rs. 116. This then increases the figure of total replanting cost to Rs. 329.40 plus Rs. 116 or Rs. 445-40 per acre.

### 3. CROPS AFTER REPLANTING

Results obtained have not been very spectacular, in fact the plot of 6 acres has been almost a complete failure and can be disregarded as worthless at present.

The soil in this six acres is micaceous and worn out, and apparently no form of manure or cultivation will encourage a good stand of young tea to grow.

Results in the remaining two plots, 20 acres in extent, are however, much more encouraging. The stand of tea is not all that had been hoped for, but this area has now been in light plucking for the past nine months and 2,772 lb. of made tea have been harvested from this acreage, although part of this area is still not yet productive.

Taking, however, this crop as the return for the whole area of 26 acres replanted, this represents a crop of 106 lb. per acre for the nine months in plucking, or the equivalent of 141 lb. per acre for a full season of 12 months.

Thus it will be seen that the comparison at present between the area, before and after replanting, stands as follows :—

Before Replanting :—
26 acres averaging 116 lb. made tea per acre per annum.

After Replanting :—
26 acres yielding the equivalent of 141 lb. per acre during the first year of plucking.

It is too early yet to forecast how soon the area will pay for having been replanted, but the first year's result would seem to indicate that the experiment will be a financial success in the not too far distant future.

The lessons to be learnt from this small experiment in replanting are interesting.

Firstly, the area to be replanted should be carefully examined. The first thought is naturally to replant the worst areas. It would appear, however, that on some of the older estates there are areas, particularly where the soil is poor and micaceous, which are not successfully replantable. Moreover, there is, of course, some reason for the uneconomic state of the area. It may be the jat of the tea or it may be the soil. If it is the soil, there is no reason to suppose that by replanting the tea will become economic, the soil itself is at fault and obviously it will be easier and less expensive to put the soil itself right, if possible, rather than replant and then also have to put the soil in order.

If the fault lies in the jat of the tea, then replanting should be the cure.

In the particular case of the six acres mentioned above, it was thought that the jat of the tea was at fault. The jat of the tea was poor certainly, but in practice it was found to be the soil that was primarily at fault, which causes speculation as to whether a wretchedly poor and wasted soil, can, by denying the needed foods, give tea the appearance of a small leafed jat through continued starvation?

Secondly, a liberal estimate must be allowed. Wherever tea is uneconomic it is reasonable to suppose that the soil must in some measure be at fault and that, therefore, it is unlikely that replanting will be as successful as in the usual new clearing.

Generally speaking, results of this small experiment so far have shown that replanting is not to be too lightly undertaken, and that careful investigations should first be made to ascertain the real cause of the uneconomic state of the tea.

It should also be borne in mind, however, that this experiment in replanting was undertaken with the object of increasing the number of economic yielders on the estate, and was carried out as an alternative to supplying.

Thus supplying costs over the four-year period were saved and may be set off against the cost of replanting.

Supplying costs for the period 1935 to 1939 totalled Rs. 10,074-41.

Replanting costs for the period 1939 to 1943 totalled Rs. 445.40 × 26 or Rs. 11,580.40 — not very much more.

Has the objective of increasing the number of economic yielders been attained ?

It is yet too early to say for certain, but it is submitted that with a yield of 141 lb. per acre from immature 4-year-old bushes, it is likely that these will prove more economic than the original old tea which apparently yielded only 116 lb. per acre.

It should be possible, when the area reaches maturity, to reach more definite conclusions regarding the merits of replanting as compared with supplying.

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# PYRETHRUM CULTIVATION IN KENYA *

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(Revised and Amended, 1943)

The cultivation of pyrethrum in Kenya has expanded very rapidly within recent years as illustrated by the figures appended below :—

Output of Kenya Pyrethrum (1934-42).

| Years | | Tons |
|---|---|---|
| 1934 | ... | 54.5 |
| 1935 | ... | 321.6 |
| 1936 | ... | 1,078.2 |
| 1937 | ... | 989.2 |
| 1938 | ... | 1,864.1 |
| 1939 | ... | 2,869.3 |
| 1940 | ... | 5,859.9 |
| 1941 | ... | 5,763.3 |
| 1942 | ... | 5,469.4 |

The expansion of the pyrethrum industry in Kenya is in large measure due to the high toxicity of the Kenya flowers which has enabled them to secure a premium on the world's markets, together with high average yields per acre and efficient methods of preparation and marketing of the product.

The crop will grow under a wide range of conditions in Kenya, but yields best at the higher altitudes over 7,500 ft. where the rainfall is fairly evenly distributed throughout the year, without a prolonged dry season. In such areas the crop can be regarded as of permanent value occupying

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an important place in the economy of the farm, whereas at altitudes below 7,500 ft. it is a valuable sideline, but it is doubtful whether its cultivation under 7,000 ft. is justified except during periods of exceptionally high prices or where other factors, such as heavy rainfall and low temperatures may in part compensate for the other disadvantages of a low elevation. Unlike most other plantation crops pyrethrum can be established at a comparatively low cost per acre and can easily be eradicated if prices or other factors cease to justify cultivation, and for this reason there is always likely to be a considerable fluctuating acreage of marginal land devoted to the crop, in addition to those areas at the higher elevations where it will probably occupy a permanent place in the economy of the farm.

The crop flourishes on a very wide range of soils throughout the Colony but on land where water-logging is likely to occur due to hard pan close to the surface or its low-lying character, the plants will rapidly die out during the rainy season. Soils which are very loose in character and on which rooting is difficult, such as rich humus forest soils where the land has been recently cleared, do not give such high yields owing to the difficulty of maintaining a good stand of the plants and a tendency to grow vegetation rather than to produce flowers. Furthermore, the weed-growth on such soils is likely to be very heavy and constant weeding tends also to reduce the stand of the plants.

The highest yields in the Colony have usually been obtained on the top of the open ridges in the high altitude areas in which the soil is a medium loam, free-draining and easy to cultivate and where the weed-growth is not usually very heavy and in such areas yields as high as 1,200 lb. per acre of dry flowers per annum have been recorded over considerable acreages.

The value to the farm of a crop producing a high return per acre with relatively low initial capital expenditure cannot be overstressed since in those areas where it is likely to prove of permanent value it will tend to reduce the economic size of the farm and also provides a rotation crop in areas where few such exist. While it may seem paradoxical to state that a plantation crop can be regarded as occupying a place in a crop rotation, yet it will be shown that it is definitely desirable to replant a percentage of the acreage annually and hence it can occupy a place in a crop rotation. In those high altitude areas where wheat has hitherto been the predominant cash crop, the advantage of pyrethrum to rest land which may have become infected with "Take-all" disease cannot be overstressed.

The chief conditions necessary for the successful cultivation of pyrethrum may be summed up as follows :—

1. High altitude — over 7,500 feet, with evenly distributed rainfall of 40-45 inches.
2. Soils on which weed-growth is not excessively heavy, and on which the plants can obtain a firm root-hold.
3. Absence of conditions likely to produce water-logging.
4. Moderate fertility — excessive fertility in the soil is likely to produce heavy weed-growth, and growth of leaf at the expense of flowers, but some growers have made the mistake of planting the crop on poor soils with the idea of reducing weeding costs. This is, of course, a mistake as it will lead to reduced yields.
5. Control of soil erosion. The crop is likely to suffer considerably from the effects of soil erosion and it is essential to take the necessary

preventative measures such as contour ridging etc. more particularly where the soil is shallow.

6. The establishment of a good stand in the field. An indifferent stand will never produce a full crop. When the stand becomes reduced. it is necessary to plough out the plantation and replant.

8. Clean Weeding. This is absolutely essential both within the plants themselves and in the rows between the plants.

*Cultivation of the Crop.*—Thorough cleaning and preparation of the land is essential, since it is not possible to perform thorough cultivation after the crop has been established and delayed attempts to eradicate couch usually involve the removal of a considerable number of plants. For this reason hand-decouching and burning should be performed if necessary and several crops of couch may be removed by repeated ploughing, cultivation with spring-tinned cultivators, collection and burning before the land is finally cleaned. In the case of old wheat lands germination of weed seeds by thorough cultivation should be effected. Deep cultivation (in excess of 6-8 ins.) does not appear to be necessary for the crop which is shallow-rooted by nature and a reasonably firm bed is desirable before planting out so as to secure a good stand. When the land has been cleaned, it should be contour-terraced prior to planting in order to prevent erosion of the soil. This is best effected by the construction of narrow-base ridges which are on the usual variable grade recommended for arable crops, but in the case of exceptionally absorbent soils level base terraces may be employed. The banks should be approximately 5-6 feet wide and about 18 to 25 inches high with a shallow drain 3 feet wide on the upper side. Pyrethrum can be planted over the banks and their shape should be maintained when cleaning by drawing the soil upwards. It is estimated that a native can contour 30 yards of such bank daily by hand with a jembie and shovel, so that the cost of protection per acre is relatively small.

It should again be emphasised that it is only advisable to construct level base terraces provided the soil is absorbent and heavy storms are not experienced. In an area of low rainfall the level base terrace is an advantage since its construction ensures that all the rain will remain on the field.

It is essential in the case of variable grade terraces to construct suitable outlets at the edge of the field to carry away the water which runs off and in the construction of the terraces it is necessary to build them up well if they cross former gullies so that they may not break away during heavy rains.

Planting should be carried out in the main general direction of the contour ridges but provided the land has been adequately protected by ridges there is no need to plant exactly on the contour. By following the general line of the contours cultivation up and down slopes will be avoided.

*Manurial Requirements.*—Experiments on the application of fertilisers to pyrethrum have been in abeyance due to the war but farming opinion is still divided on this question. Applications of superphosphates have in some cases been followed by increased weed-growth with a consequent increase in weeding costs and a reduction in stand due to these frequent weeding. In other cases farmers have found that such applications gave an increase in the numbers of flowers, individual flower size, and an increase in yield of the plantation.

On poorer soils, or on land which has been under pyrethrum for a few years and which has been cleared and ploughed for replanting, preliminary trials with dusting the holes with bonemeal or guano at the

time of planting indicate that the young plants make a better and more vigorous growth.

The pyrethrum crop does not remove heavy quantities of plant foods. A 1,000 lb. crop of dried flowers removes 17 lb. nitrogen, 25¾ lb. potash, 5¾ lb. phosphoric oxide and 4¼ lb. lime, amounts that would be supplied by 85 lb. sulphur of ammonia, 30 lb. superphosphate and 51 lb. sulphate of potash or, taking wartime fertilisers, 175 lb. hoof-and-horn meal and about 200 lb wood ash.

*Planting Material.*—The two types of planting material used are either seedlings or root divisions from existing plants. A considerable diversity of opinion exists as to which are the best to use, but it would appear that it is usually easier to establish a field with seedlings since they have a better root system and withstand transplanting better under unfavourable conditions than root divisions. At the same time, a considerable amount of labour and supervision is required for tending the seed beds and seedlings do not come into flower so quickly after transplanting as root divisions. At the lower elevations, however, where a percentage of non-flowering or low-producing plants are usually found in cultivations established from seedlings, it may be possible to eliminate these by selection of plants for root divisions which have shown ability to flower and yield well under the particular conditions prevailing.

### A. SELECTION OF ROOT DIVISIONS

It is important to select material for root divisions carefully from high-yielding plants, and this applies particularly at the lower elevations. The common practice of removing every plant over a certain area for purposes of obtaining root divisions should not be encouraged, but more attention should be paid to the selection of planting material. The non-flowering or dark-green coloured "cabbage" looking plants should be discarded completely, and, generally speaking, the more silvery coloured and feathery-leafed plants will be found the most desirable type to propagate. Material to be used for splitting should have all flowering stems cut off before it is dug up and attempts should not be made to obtain too many root divisions from one plant. Small spindly divisions with little or no root system will be found difficult to establish and replanting and patching subsequently will be necessary. Care should be taken to ensure that every split (division) when planted has part of the root system of the parent plant and contains a due percentage of foliage. A large number of individual plants should be used to establish a plantation and attempts should not be made to establish a plantation from one or two high-yielding plants propagated repeatedly by root divisions. The reason for this is that the pyrethrum plant is self-sterile and it is necessary to have a large number of individuals in the field so as to ensure adequate pollination which is necessary in order to obtain a high pyrethrin content in the flowers. Also it is necessary to guard against selection of plants having flowers of of low pyrethrin content.

### B. SEEDLINGS

A considerable number of farmers will continue to plant their plantations from seedlings on account of the greater ease with which they can be established in the field more particularly during unfavourable conditions and also the high cost of obtaining splits if it is necessary to buy when plants are not already available. *It is of importance to use seed the origin of which is known and which has been harvested from carefully selected material.* Limited supplies of seed from selected high pyrethrin content plants are now being produced by the Department of Agriculture and these are distributed by the Pyrethrum Board of Kenya. Farm seed plots should be established from a large number of individual plants selected in the field for

such characters as flower size (size of centres), number of flowers, upright non-straggling habit and high pyrethrin content and these should be planted all together in a plot by themselves and used for seed production. A large number of plants should be used for this purpose, so as to avoid any possibility of partial sterility through lack of sufficient numbers of individuals for cross-pollination.

The seed should be harvested when the disc florets have died and tend to fall off the flower head, exposing the greyish-brown seed. The seed should not be stored for long periods as it loses its viability fairly rapidly. One pound of seed is usually adequate to plant one to three acres in the field according to the spacing. The seed does not usually germinate more than about 50 per cent in the seed-bed and germination is slow and irregular, taking about 12-14 days.

*Seed Beds.*—The seed beds should be made on well-drained soil which is carefully and evenly levelled. Owing to the slow rate of germination of the pyrethrum seedlings, it is desirable to obtain a thorough germination of the weed seeds first before the pyrethrum seed is planted. Overhead shade should be provided for the seed-beds and it is advisable to thatch the soil itself with a light covering of grass until the seedlings have germinated. The seed should be scattered lightly over the beds and covered with a very thin layer of soil and watered daily. The grass covering will be removed at about the 12-14th day when the majority of the seed has germinated. If any signs of damping off appear, the shade should be removed and plants watered with water tinted with permanganate of potash. Pricking out of the seedlings about 3 ins. by 3 ins. apart is to be recommended, as this stimulates root development and will hasten the time at which they will come into bearing when transplanted into the field. Although this operation increases the labour costs, it is doubtless well worth while since a return is secured much more quickly. It is important that the seedlings should be well grown before they are transplanted into the field and should have at least 10-12 leaves. If smaller seedlings are transplanted, they frequently become buried with soil when heavy rain falls at the time of transplanting into the field, and flowering will of course be delayed.

*Transplanting into the Field.*—A considerable amount of experimental work has been carried out on the correct spacing for pyrethrum and it would appear that in the high altitude areas a square spacing of 2 ft. by 2 ft. is likely to give the most satisfactory results. On rich forest soils, however, where rooting is loose and weeding expensive, it is advisable to adopt a somewhat wider spacing between the rows, spacing the plants closer together in the rows. In this manner more mechanical cultivation with oxen and donkeys can be performed and there is less danger of loosening the roots of the plants. Under such conditions spacings of 2 ft. 6 ins. or even 3 ft. between the rows, and 16 ins. to 18 ins. between the plants in the rows are recommended. Latterly however, many farmers are adopting a narrower spacing in the row coupled with a wider inter-row spacing of 1½ ft. by 3 ft. planted on the contour. This spacing makes for ease of cultivation, cheapens weeding costs and lessens soil erosion.

The approximate numbers of plants required per acre of the more common spacings are as follows :—

| | | | |
|---|---|---|---|
| 2 ft. × 2 | ft. | 11,000 | plants per acre. |
| 3 ft. × 1½ | ft. | 10,000 | „ „ „ |
| 3 ft. × 2 | ft. | 7,400 | „ „ „ |
| 3 ft. × 3 | ft. | 4,900 | „ „ „ |

At the lower altitude (7,000 ft. to 7,500 ft.) where growth is not so vigorous a square spacing of 20 by 20 ins. is recommended, except for rich forest soil condi-

tions when the spacings adopted should be similar to those previously recommended.

The fields should be carefully marked out prior to planting and it may be desirable to leave paths at intervals to facilitate handling the crop. If, however, wide spacings between the rows have been adopted, this will not be necessary, and even with a 2 ft. by 2 ft. spacing is not essential.

If the field is being planted with splits, an entrenching tool should be used for digging the holes prior to planting out. Great care should be exercised in splitting up the plants to ensure that each split has a part of the parent root system and the plants should be firmly planted in the ground and the soil well tamped round them. *Carelessness in firming the soil round the roots of the plant is a frequent cause for a poor stand subsequently due to high mortality.* In the case of seedlings. the holes can be prepared with a pointed stick, but care should be taken to ensure that the roots point properly downwards and soil is well consolidated round the plants. Approximately 10 to 14 boys will plant 1 acre daily, but it is work that requires the closest supervision and should not be unduly hurried. Failure to secure a good stand will result in low yields and a short life of the plantation. A certain percentage of plants, more particularly on the looser soils are, however, likely to die due to defective root system or other causes and such gaps should be replanted as soon as possible before the rest of the plantation has commenced to flower. If attempts are made to patch up fields which have come fully into bearing, the results are never likely to be satisfactory owing to the difficulty of establishing the replanted material and the slow rate at which they will come into production, due to the competition from mature plants.

Fields established from splits should, at the high altitudes, commence to flower approximately 14 weeks after they have been planted, while seedling material will probably take about 8-12 weeks longer. These periods are increased somewhat at the lower elevations where a percentage of the plants established from seedling material may even remain for a period of one year before commencing to flower, and the same may apply to a percentage of the root divisions unless these have been very carefully selected. There is a considerable difference of opinion as to the advisability of cutting off the flowering stems when the young plants begin to flower in order to stimulate their vegetative growth. Provided, however, good sized seedlings or splits have been used originally, there is no particular advantage in adopting this practice and picking of the flowers should commence as soon as possible.

*Cleaning and Harvesting.*—As previously mentioned it is absolutely essential to keep the crop clean both from weeds between the plants and in the plant themselves. A certain amount of mechanical cultivation can be performed with small ox cultivators pulled either by an ox or a donkey, the latter being more suitable for work between fairly close rows. While the plants are young, the majority of the weeding can be done in this manner, but care should be taken to remove all weeds growing in the plants themselves. The worst of such weeds is probably the Sorrel (*Oxalis* spp.) which grows up in the plant and eventually kills it, thus shortening the life of a plantation considerably and it is important to take care when planting from root divisions that these are free from the weed. Indigenous clovers also grow up in the plant and are extremely difficult to eradicate. On forest soils, where weed-growth is heavy it may be necessary to weed as frequently as every 14-17 days during the rains, but as a general rule the period varies from a month to six weeks or more. The use of a Dutch or turnip hoe as opposed to the jembie for weeding is encouraged since it does not do so much damage and

it is quite effective for the work, provided weeds are not allowed to grow much beyond the seedling stage, which is essential if the plantation is to yield well. Some farmers use Planet Junior hoes pushed by hand for weeding. These are quite effective for performing the work, particularly in the early stages of the life of a plantation, but should not be used exclusively owing to their tendency to encourage the formation of a pan. It is desirable that an established plantation should be given at least one cultivation with ox cultivators annually to burst up the soil on the surface which has become packed owing to the frequent treading during picking, etc. and the operation is best performed immediately after the plantation has been cut back. The cultivators should penetrate about 2½ ins. below the surface but not deeper, otherwise they would tend to loosen the plants in the soil.

Weeders often make the common mistake of drawing the soil away from the plant when hand weeding with a jemoie, until eventually the plants tend to sit on a small cone of soil; this type of weeding should be prevented since it exposes the root. Benecial results have been obtained by lightly running a ridging plough between the lines of plants along the contour; this has the effect of throwing the soil back to the base of the plants and also tends to prevent erosion.

Failure to keep pace with weed-growth will sooner or later necessitate thorough deep weeding, which removes a large percentage of the plants. The acreage of pyrethrum which will be grown on any farm is therefore likely to be limited by the amount of labour available for cleaning and picking. Under average conditions one boy is continuously employed in cleaning approximately 5 acres, although this figure will vary very widely.

*Picking.*—It is important that flowers should be picked when there is no external moisture on them, either dew or rainfall, which is likely to cause heating before the flowers are dried. Such heating would be deleterious to the colour and appearance of the dried product and also to its pyrethrin content. For these reasons picking should not be commenced early in the morning until the dew has dried off the flowers. The flowers should be picked into wickerwork baskets which permit of access of air at the sides so as to prevent heating and if they are not removed to the drying plant for sometime, should be spread out on tarpaulins when the baskets have been filled. The average amount of flowers picked per day varies from 25-30 lb. wet flowers depending on the size of the crop and the nature of the labour employed and amounts considerably in excess of this may be picked during periods of heavy flush. While during the dry season the amount may fall to 12-15 lb. daily.

Observations carried out showed that pickings may range as low as 9 lb. per acre of dried flowers per picking to 250 lb. per acre dried flowers per picking during the heaviest flush periods in high altitude pyrethrum growing areas.

Great care should be exercised over the picking operations so as to ensure that flowers only at the correct stage of maturity are harvested, *i.e.*, when at least 3-4 rows of disc florets are fully open, and that the picking of immature flowers and buds, which would result in the lowering of the pyrethrin content, is avoided. The flowers should not be packed tightly in the receptacles into which they are picked, but allowed to fall in loosely. Payment for picking is usually made on the basis of weight and varies from ¾-1 ct. per pound of wet flowers, although the work can often be performed slightly more cheaply by the employment of monthly labour at a fixed wage who are given a minimum task of 25 lb. of wet flowers daily, picking in excess of this amount being paid extra depending on the amount picked. Picking is performed roughly at fortnightly to

three weekly intervals throughout the flowering season which may continue for 8-9 months of the year. It is important, however, always to examine the flowers carefully in the field before commencing to pick rather than to attempt to follow any definite time interval.

Flowers should be removed to the drier as rapidly as possible after picking. Artificial driers of the Ainabkoi type are the most popular at the present time, although these are being continually improved to make them more efficient and to produce a uniform sample of high pyrethrin content.

*Cutting Back.*—At the end of the flowering season the pyrethrum plants have a large number of dead flowering stems and it is desirable to cut these back before the onset of the next growing rains. The level to which the plants should be cut back has been a matter for dispute and for this reason experiments have been carried out to determine the correct method. The treatments adopted were as follows :—

1. Control — Uncut.
2. Cut high — Flowering stems only removed.
3. Intermediate — Half foliage cut in case of tufted plants and remainder of plants cut half through.
4. Cut to ground.

Half of the area was also again cut in the middle of the flowering season to test whether it was possible to alter the time of flowering by cutting at periods other than before the onset of the rains. Results of this indicated that it is definitely inadvisable to try to alter the time of flowering by cutting at season other than the normal dry or dormant season. Results of the trials of different methods of cutting back are appended below :—

| | Cut once in dry season lb. dry flowers per acre | All cut high again during rains lb. dry flowers per acre |
|---|---|---|
| Control ... ... | 1,555.5 | 417.0 |
| Cut High ... ... | 1,612.6 | 521.2 |
| Intermediate ... ... | 1,213.7 | 424.6 |
| Cut to ground ... ... | 877.1 | 294.0 |

The plants which are cut to the ground have never grown to the same size and it would appear that this treatment would only be desirable if it were intended to rejuvenate an old plantation in order to permit of more thorough cultivation.

*Yields.*—Yields vary very greatly throughout the pyrethrum growing areas, but are influenced largely by altitude and nature of the soil, the highest yields being obtained at altitudes over 8,500 on soils which are of a medium loam character Under these conditions. yields of 900 to 1,000 lb. of dry flowers per acre per annum are sometimes obtained while at lower elevations down to 7,000 feet yields in the neighbourhood of 500 to 600 lb. of dry flowers can be obtained. On rich forest soils with a very high humus content the yields will be lower, say in the neighbourhood of 550 lb. per acre at 8,000 ft.

Though the foregoing yields are commonly obtained, yields for the Colony have been on a lower scale. It is not possible to give exact figures because a proportion of newly-planted acreage is always included in the statistics, but the average appears to have varied generally between 300 and 600 lb. per acre in different years, the overall acreage to date being in the region of 400 lb. per acre per annum.

*Life of a Plantation.*—The useful bearing life of a plantation will vary considerably with soil, altitude, rainfall and other factors. Except, however, in the highest altitudes the life of the plantation will probably be from 3-5 years since considerations of weeding, reduction in stand, compaction of the soil will probably render it desirable to replant before this age is reached. The chief indication of a need for re-establishment is a reduced stand with consequent severe reductions in yield and increased weeding costs. It is essential therefore that a definite replanting programme should be adopted every year, the percentage to be replanted being based on the average useful life of a field for the particular conditions obtaining. Thus on a loose forest soil where the useful life may be only three years it will be necessary to replant about 33 per cent of the acreage annually, whereas in the high altitude areas on the tops of the ridges 15 to 20 per cent will be sufficient for annual replanting. It is highly problematic if in a well-looked after pyrethrum plantation the pyrethrin content decreases with increasing age. Flowers taken from a plantation eleven years old compared extraordinarily well in pyrethrin content with flowers from an adjacent new plantation. At the Scott Agricultural Laboratories in a plot six years old, there has been no significant loss in pyrethrin content. It has also been widely stated that flowers from splits have a lower pyrethrin content than the parent plant. This is one of the many untrue legends pertaining to the growth of pyrethrum. Flowers from splits are as good as the flowers from the parent plant. There is one proviso covering these statements — they apply to good farming practice. If a field is allowed to become weedy, then one may expect with increasing age, a decrease in the pyrethrin content — the plants are not healthy. Again, if splits are badly planted and not looked after, then a lower pyrethrin content will accrue.

It is suggested that when pyrethrum has been removed from a plantation, it should not be replanted immediately but other crops such as peas or cereals should be planted for a period of one year or more so that weed such as sorrel can be effectively destroyed and also other types of weed largely prevalent in pyrethrum.

This article deals with the cultivation of pyrethrum only and not with the drying of the crop. An article on the latter was published in the *East African Agricultural Journal* for January, 1937, and plans and specifications of the Ainabkoi Drier, the type recommended by the Department of Agriculture and the Pyrethrum Board, are obtainable from the Kenya Farmers' Association (Co-operative) Ltd., Nakuru.

# MINUTES OF A MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD 26-11-43

Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon held at the Ceylon Chamber of Commerce Rooms, Colombo, on Friday, 26th November, 1943, at 3 p.m.

*Present.*—The Chairman, T. R. I. (Adigar Sir T. B. Panabokke); the Deputy Financial Secretary (Mr. C. E. Jones, C.C.S.) representing the Financial Secretary; the Director of Agriculture (Mr. E. Rodrigo, C.C.S.); the Chairman, Planters' Association of Ceylon (Mr. N. H. W. Dulling); the Chairman, Ceylon Estates Proprietary Association (Mr. R. Mann); Messrs. R. G. Coombe, G. K. Newton, H. St. J. Cole-Bowen, Major J. W. Oldfield, C.M.G., O.B.E., M.C., Messrs. J. C. Kelly, W. H. Gourlay, W. P. H. Dias and Dr. R. V. Norris (Director and Secretary).

Mr. J. A. Rogers (Superintendent, St. Coombs) was present by invitation.

(1). The Notice convening the Meeting was read.

(2). The Minutes of the Meeting of the Board held on the 28th September, 1943, were confirmed.

## 3. MEMBERSHIP OF THE BOARD

Reported that the nominations of Messrs. R. G. Coombe and G. K. Newton, as representatives on the Board of the Planters' Association of Ceylon, had been renewed for a further period of 3 years as from 1st January, 1944.

## 4. FINANCE

The Institute's Accounts to 31st October, 1944, had been issued to members.

Reported that since that date a sum of Rs. 40,000 had been invested in Ceylon Government 3¼ per cent National Loan maturing in 1955. The Board confirms this action and the accounts were recorded.

*Cess.*

Reported that the Ordinance authorising the collection of the Research Cess at 14 cents per 100 lbs. tea up to the 31st December, 1948, had been passed by the State Council on the 18th November. Major Oldfield was thanked for his services in this connection.

*Research and Estate Estimates for 1944.*

(i) *Revised Forecast of Receipts and Expenditure 1943.*—The Director said it was now unlikely that the anticipated profit on St. Coombs would be realised.

(ii) *Forecast of Receipts and Expenditure 1944.*—It was noted that in view of the reduced crop likely to result from shortage of fertilisers, no profit on St. Coombs was to be anticipated unless an increase were made in the contract price for tea in 1944.

*Research Estimates.*—On the motion of Mr. Coombe, seconded by Major Oldfield, the Research Estimates, amounting to Rs. 268,060, acceptance of which was recommended by the Finance Committee, were approved subject to provision of increased provision for dearness allowance to the Junior Staff, the latter being granted on the Government rates to all staff on salaries not exceeding Rs. 400 per mensem with effect from 1st November, 1943.

*Estate Estimates.*—It was noted that the estimated crop of 200,000 lb. was dependent on fertilisers being available; otherwise crop was estimated at 175,000 lb. with an increase in cost of production of about 4 cents per lb.

The Board agreed to the allocation of general charges in the proportion of 97½ per cent to working account and 2½ per cent to capital.

*Vote 29, Prevention of Soil Erosion Measures.*—Mr. Dulling suggested that if the labour position admitted it, increased provision under this vote should be sought.

*Vote 57, Factory Watchman.*—It was considered that a man of better status than a labourer in the check-roll was required for this purpose and the Superintendent was instructed to make the necessary arrangements to recruit a suitable man on a salary of Rs. 30-40 per mensem.

*Vote 65.*—In view of the somewhat high consumption of cylinder oil, the Superintendent was instructed to obtain an engineering opinion of the condition of the engines.

Subject to any modifications necessitated by these suggestions the estate estimates (Working Account 97.84 cents per lb., Capital Account 3.28 cents per lb.) were approved on the proposition of Mr. Dulling, seconded by Mr. Dias.

*Government Loan.*

In view of the cess now being fixed at 14 cents up to 31st December, 1948, the Board confirmed its decision to increase the annual repayments by Rs. 25,000 above the present figure. The Director was instructed to make official representation to the Financial Secretary for sanction to this action.

## 5. ST. COOMBS ESTATE

*(a) Visiting Agent's Report dated 19th October, 1943.*

*Labour.*—Mr. Dulling pointed out that the reference to there being little or no movement of labour "in the Island" might be misunderstood. What was no doubt meant was that there had been little or no local movement in regard to St. Coombs labour. The Director said he would call Mr. Tonks' attention to this.

The Report was recorded.

*(b) Minutes of Estate and Experimental Sub-Committee Meeting held on the 6th November, 1943.*

Arising from these Minutes the Board considered the question of War Risk Insurance of buildings and machinery on St. Coombs.

It was pointed out that St. Coombs presented a somewhat conspicuous target and differed from an ordinary estate, in that it was the property of the tea industry as a whole.

After discussion it was decided to take cover under the terms of Ordinance No. 62 of 1942 in respect to the Factory, Power House, Pump House, T. R. I. Laboratory, and Machinery in these buildings. Cost was estimated at about Rs. 1,000 per annum.

*(c) Superintendent's Leave.*

In view of the impossibility of taking the normal leave due to him, the Superintendent was granted one month's special leave to India to be taken early in January.

The Board also agreed that Mr. Jones-Pughe, Superintendent of Mattakelle Estate, be invited to undertake the supervision of St. Coombs Estate during Mr. Rogers' absence.

*(d) Food Production and Development of Patna Areas.*

Reported that it had not been possible to make arrangements with the Rubber Research Scheme for participation by the Tea Research Institute in the Rubber Research Scheme food production clearing.

In these circumstances the Estate and Experimental Committee had repeated its recommendation that the Institute should contract out owing to the difficulties in regard to arranging labour and supervision in any scheme outside St. Coombs.

The Director reported that since the meeting of the Estate and Experimental Committee an offer had been received from a planter to supervise the clearing and cultivation of a small area in the Hiriyala Hatpattu, Kurunegala District.

Considerable doubts were expressed by Members of the Board as to the possibility of obtaining a regular supply of labour for this project and the Director was instructed to consult the G. A., Kurunegala, as to the position in regard to both land and labour so that the matter could be further considered at the next Board Meeting.

*Development of St. Coombs Patna.*—The Director said this matter had been considered by the Estate and Experimental Committee. The only area suitable, on account of slope, was a block of two or three acres adjacent to the caddai and this presented difficulty on account of water supply.

The Director said he and Mr. Rogers had visited Delta to see similar work being carried out there by Mr. Shand. It seemed clear that pig keeping offered the best chances of developing the area but he thought a portion of the block would have to be put down to fodder grasses in view of the scarcity of feeding materials for stock. In this connection Mr. Rodrigo suggested Guatemala grass might prove successful.

Major Oldfield thought a good deal of feeding material for pigs could be obtained by an organised collection of bungalow waste.

The Board decided that the work should be taken up on the above lines.

## 6. JUNIOR STAFF

Reported that Dr. J. G. Shrikhande, Research Assistant to the Agricultural Chemist, had resigned his appointment with effect from 15th October, 1943, to take up a post in India.

An advertisement for an officer on the same scale, Rs. 200-20-400, per mensem, would shortly be issued.

The Board approved the Director's suggestion that the officer selected might be started at a point in the above salary scale commensurate with his qualifications.

## 7. ANY OTHER BUSINESS

It was decided to hold the next Meeting of the Board in Colombo on Friday, 17th December, 1943.

The Meeting then ended with a vote of thanks to the Chair.

ROLAND V. NORRIS,
*Secretary.*

# MINUTES OF A MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD 17-12-43

Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon held at the Ceylon Chamber of Commerce Rooms, Colombo, on Friday, 17th December, 1943, at 3 p.m.

*Present.*—The Chairman, T. R. I. (Adigar Sir T. B. Panabokke), the Hon'ble the Financial Secretary, (Mr. H. J. Huxham), the Chairman, C. E. P. A. (Mr. R. Mann), Major J. W. Oldfield, C.M.G., C.B.E., M.C., Messrs. J. C. Kelly, W. H. Gourlay, W. P. H. Dias, and Dr. C. H. Gadd (Acting Director and Secretary).

Letters regretting inability to attend had been received from the Director of Agriculture (Mr. E. Rodrigo), Messrs. R. G. Coombe, H. St. G. Cole-Bowen, and the Chairman, Planters' Association of Ceylon (Mr. N. H. W. Dulling).

1. The Notice convening the meeting was read.

2. The Minutes of the Meeting of the Board held on 26th November, 1943, were confirmed.

## 3. FINANCE

*Government Loan.*—Reported that the Director had made formal application to the Hon'ble the Financial Secretary to increase the annual repayment of the Government Loan to Rs. 100,000 as from September, 1944. A reply had not yet been received.

## 4. ST. COOMBS ESTATE

*(a) Acting Arrangements during Superintendent's Leave.*—Reported that Mr. J. G. Jones-Hughe, Superintendent of Mattakelle Estate, had, with his Agents' consent, accepted the Board's invitation to act for Mr. Rogers while on leave.

*(b) War Risk Insurance.*—Reported that an application has been made for cover under the War Damages (Immovable property) Ordinance No. 62 of 1942, and that during an interview with the Director, the Commissioner stated that the Institute's proposal would be accepted. An official statement of premium due is expected later.

*(c) Dispenser.*—Reported that the Superintendent of Kowlahena Estate had informed the Director that his dispenser, owing to the amount of work in hand, would from January 1st, 1944 be unable to attend to St. Coombs' patients as in the past and had requested the Institute to make other arrangements. It had not been possible to make satisfactory arrangements to share a dispenser with any other adjacent estate.

The Acting Director was authorised to appoint a whole-time dispenser at Rs. 75 per month with dearness allowance, house, and provident fund benefits.

## 5. FOOD PRODUCTION

Reported that in reply to enquiries made by the Director concerning land suitable for Food Production in Hiriyala Hatpattu near Wattamana, the Government Agent, N.W.P. had replied the only Crown land available is situated in the dry zone where labour is difficult to obtain.

The Acting Secretary read the Director's letter dated December 1st, 1943, and the reply by the Government Agent, N.W.P.

It was decided that in view of the labour difficulties the scheme under consideration in the North-Western Province should not be proceeded with.

After discussion, it was further decided that the Minister for Agriculture should be informed of the efforts made by the Board concerning Food Production and asked for suggestions of other possible schemes.

### 6. SENIOR STAFF

*Salary Increments.*—The Board sanctioned normal salary increments (Rs. 50) per mensem to the undermentioned officers :—

Dr. F. R. Tubbs from 1st February, 1944.
Mr. J. Lamb from 12th February, 1944.
Dr. T. E. T. Bond from 8th Feby., 1944.

### 7. ANY OTHER BUSINESS

*(a) Co-operative Society.*—The Acting Director outlined a scheme for the extension to the estate labour force of "The St. Coombs Co-operative Stores Society, Ltd." an existing Co-operative Society managed by the Junior Staff.

A general discussion followed in which complete agreement was shown with the desire to encourage the co-operative movement amongst the Institute's employees. The Acting Director was instructed to refer the subject to the Estate and Experimental Committee to determine the best method of establishing a Co-operative Store for the labour force.

*(b) Chemistry of Tea.*—Major J. W. Oldfield enquired concerning the progress of the London investigations into the chemistry of tea. The Acting Director replied that he had received a report from London only the previous day but had not then been able to study it closely. The report will be communicated to the Board as soon as possible.

*(a) Chairman of the C. E. P. A.*—Mr. Mann informed the Chairman that Mr. C. H. Bois would be acting for him while on leave.

C. H. GADD,
*Acting Secretary.*

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# MINUTES OF A MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD 28-4-44

Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon held at the Ceylon Chamber of Commerce Rooms, Colombo, on Friday, 28th April, 1944 at 2-30 p.m.

*Present.*—Sir T. B. Panabokke, First Adigar, (Chairman), Mr. C. E. Jones, representing the Hon'ble the Financial Secretary, the Chairman, Planters' Association of Ceylon (Mr. N. H. W. Dulling), the Chairman, Ceylon Estates Proprietary Association (Mr. R. Mann), the Director of Agriculture (Mr. L. J. de S. Seneviratne, C.C.S.), Major J. W. Oldfield, C.M.G., O.B.E., M.C., Messrs. J. C. Kelly, W. H. Gourlay, G. K. Newton, W. P. H. Dias, H. St. J. Cole-Bowen and Dr. R. V. Norris (Director and Secretary).

A letter was tabled from Mr. R. G. Coombe expressing inability to be present.

(1) The notice convening the meeting was read.

(2) The Minutes of the Meeting of the Board held on the 17th December, 1943 were confirmed.

## 3. MEMBERSHIP OF THE BOARD AND COMMITTEES

(i) The Chairman welcomed Mr. L. J. de S. Seneviratne, C.C.S., who joined the Board as an *Ex-Officio* member on taking up the appointment of Director of Agriculture as from 14th February, 1944. The Chairman also referred to the services rendered by Mr. E. Rodrigo, C.C.S., the former Director of Agriculture, and asked the Board to record their appreciation of these.

(ii) The Chairman mentioned to the Board that Mr. A. W. L. Turner, Secretary of the Planters' Association of Ceylon, was shortly retiring and leaving the Island.

He reminded members that Mr. Turner was appointed Secretary to the Board at its second meeting held on the 13th March, 1926, and has served the Board in that capacity until the 31st March, 1936, when the new organisation came into force.

The Chairman said the Institute was greatly indebted to Mr. Turner for the very valuable assistance he had given to the Institute, not only during his tenure of the Secretaryship but during the eight years which had elapsed since he vacated that office.

He felt sure the Board would wish to record their appreciation of these services and wish Mr. Turner all happiness in his retirement — (Applause).

Major Oldfield, as the first Chairman of the Board, particularly wished to associate himself with the Chairman's remarks and to acknowledge the great help he had received from Mr. Turner in the early days of the Institute.

The Chairman's suggestion was carried with acclamation.

## 4. FINANCE

*(i) Accounts to 31st December, 1943.*

These had been issued for information, together with a note by the Director summarising the year's working. The Chairman explained that the Auditors' Report had not yet been received and this together with the certified accounts would come before the Board at the next meeting.

*(ii) Accounts to 29th February, 1944.*

These had also been issued to members and were recorded.

*(iii) Funds with the Ceylon Association in London.*

The Board decided after discussion that the sum of £6,750 now held on behalf of the Institute by the Ceylon Association should be invested in a short term British Government Loan. The Director was instructed to ask the Ceylon Association to make the necessary arrangements.

*(iv) Tea Research Institute Loan from Government.*

Reported that the Board of Ministers had declined to agree with the Board's proposal to increase the payments on the loan from Rs. 75,000 to Rs. 100,000 annually. It was decided no further steps could be taken on this matter.

## 5. ST. COOMBS ESTATE

*(i) Visiting Agent's Report dated 18th February, 1944.*

(a) The Board approved an extra vote of Rs. 1,000 for plain forking.

(b) Mr. Dulling called attention to the Visiting Agent's comment in regard to labour. He noted that, after allowing for labour lent to the Research side, the number of working labourers was equivalent to 1.29 per acre in full bearing or 1.14 on the full acreage in tea. He thought prominence should be given to the Visiting Agent's comment that "Labour is rather short due chiefly to the increased numbers required for weeding and to the tendency of labour generally to do rather less work." Mr. Dulling thought the figures quoted would be of interest to other estates and to the Planters' Association.

(c) In reply to Mr. Kelly the Director stated that owing to exceptionally favourable weather 1944 crop to-date was approximately 30,000 lb. ahead of the 1943 figure.

(d) Much interest was expressed in the respective yields obtained from the 1937 clearings, viz :—

18-acre block, planted 4 ft. × 3 ft., ordinary planting. Yield 219 lb. per acre (pruned in August).

2-acre block, planted 5 ft. × 1½ ft., contour planting. Yield 678 lb. per acre (pruned in September).

The 1937 clearing consists of two blocks :—

(a) *2 acres.*—Planted 5 ft. × 1½ ft. on the contour. Approximate number of bushes per acre 5,800. Trenches cut instead of normal holes.

(b) *18 acres.*—Planted 4 ft. × 3 ft. ordinary planting. Approximate number of bushes per acre 3,630.

*Manuring and Cultivation.*—Manuring in both sections has been at the rate of 1 oz. manure *per bush* per annum until 1943, the above manure being given in two applications. In consequence of the difference in number of bushes per acre, the actual amount of manure applied *per acre* since 1938 has been as follows :—

2-acre contour block 155 lb. nitrogen averaging 26 lb. N per acre per annum.

18-acre contour block 96 lb. nitrogen averaging 16 lb. N per acre per annum.

The 2-acre block had further the advantage of heavy thatching with maana grass in the first four years of growth, the thatching being forked in at approximately six-month intervals and then renewed.

18-acre block on the other hand was not thatched owing to lack of material.

In regard to cultivation this has been done to both rows in the 2-acre blocks but in alternate rows in the 18-acre block.

Casualties after pruning in 1939 were higher in the 18-acre block than in the contour clearing.

*(ii) Minutes of the Estate and Experimental Sub-Committee held on 1st April, 1944.*

(a) The Director said a correction should be made in the Minutes under the heading "Manufacture." This should read "It was resolved to keep a record of the number of pounds of tea turned out per labourer in the factory, exclusive of red leaf pickers."

(b) It was noted, in future, crop figures and statistics of cost would be based on the full crop, *i.e.*, on graded tea plus broken mixed as the latter was now included in tea taken over by the Tea Commissioner.

(c) *Oil Fuel Installation.*—The Board sanctioned expenditure of Rs. 3,500 for purchase and installation of a new oil burner as recommended by the Estate and Experimental Sub-Committee.

The Director suggested that the Institute should now install a Direct-fired heater at St. Coombs. Figures already available indicated that a heater of this type possessed considerable advantages in regard to both working costs and cost of upkeep. If such a heater were installed accurate comparative figures could be obtained between this and a stove of the conventional type. In view of the acute position in regard to firewood up-country he thought such figures would be of considerable importance to the industry. Dr. Norris added that he thought the Shell Company would possibly co-operate in regard to the installation of such heater.

Mr. Newton and Major Oldfield supported the suggestion. After discussion it was decided that the Director should approach the Shell Company and that

specific proposals and estimates should be submitted to the Estate and Experimental Sub-Committee for approval.

(d) *Proposed Co-operative Society for St. Coombs Estate.*—The Director invited the attention of the Board to the recommendations of the Estate and Experimental Sub-Committee on this subject, viz :—

"(1) That to meet the needs of St. Coombs as a whole, the existing Society should be asked to extend its scope to all residents.

(2) That the Board should buy on valuation the existing caddai which is on Institute land (the Committee was of opinion that the Board should be the owner as a matter of general policy) and that notice should be given to the present owners to vacate the site.

(3) As the present accommodation for a Co-operative Society is inadequate the Board should rent the building to the Society at a suitable sum.

(4) The Board should assist the Society financially within the scope of the Co-operative Society Rules."

In this connection discussion arose concerning the St. Coombs caddai which also served Mattakelle and Waltrim estates. It was felt there might be some repercussions on these estates if the caddai were closed. The Director was asked to discuss this aspect of the question with the superintendents concerned and ascertain if these estates would join in the event of a co-operative store being established.

Mr. Cole-Bowen pointed out that labourers from these outside estates could be admitted as consumers to the St. Coombs Co-operative Society, the holding of shares being limited to St. Coombs residents. Such outside consumers would have to make cash purchases unless their accounts were guaranteed by the superintendent of the estate concerned. He pointed out, however that in such a case there might be a difficulty about stocks as these could only be obtained from the Co-operative General Stores on the basis of actual members.

Mr. Cole-Bowen thought that capital of about Rs. 5,000 would be required for the Society.

The Board was unanimously in favour of the establishment of a Co-operative Society open to the estate labourers on St. Coombs and, after further discussion, it was proposed by Mr. Newton and seconded by Major Oldfield that the proposals of the Estate and Experimental Sub-Committee be accepted. This was carried unanimously.

Mr. Cole-Bowen kindly offered to supply details regarding the working of the Co-operative Stores on his estate and, if necessary, to allow a representative from St. Coombs to visit the estate and study this on the spot.

*(iii) Food Production, St. Coombs Patna Area.*

The Board considered a letter dated 15th April, 1944, from the Superintendent, St. Coombs, in regard to the difficulties anticipated by him in carrying out the proposals made for development of a small block of the St. Coombs patna area. Mr. Rogers in particular stressed the great difficulty in obtaining foodstuffs, *e.g.*, coconut poonac for cattle already on St. Coombs and thought it inadvisable until this was solved, to contemplate the increase of stock by the purchase of pigs. The Director gave further details of the difficulty concerning coconut poonac and was instructed by the Board to take the matter up with the Civil Defence Commissioner.

Mr. Newton commented strongly on the present confusion in regard to the distribution of foodstuffs. Experience had shewn clearly that in the wet up-country areas only root crops could be produced. On his estate sweet potatoes had been

grown with success and he had had a considerable surplus over the amount required for his own labour force. Previously he had been able to dispose of his surplus through the Marketing Commissioner in Colombo at a reasonable figure, but he had later been informed that no more would be taken over. He had then seen the Manager, Vegetable Price Shed, Kandy, who had taken over one consignment, but here again he had since been informed that no further purchases would be made and he had now no means of disposing of any surplus.

Major Oldfield strongly supported Mr. Newton in regard to the lack of organisation in distribution. The position was now that while starvation conditions were reported in certain areas, there was an excess of food in other places which could not be disposed of and was wasted. He referred for example to the difficulty of obtaining in Colombo certain items of food, such as sweet potatoes which were in excess up-country.

Mr. Dulling and Mr. Mann supported Mr. Newton and Major Oldfield, Mr. Dulling reporting that on his estate he had had to employ a contractor to remove sweet potatoes which were unsaleable.

In reply to Major Oldfield, the Director of Agriculture said confusion arose through considering food as one unit. It was correct there was an excess or root crops, especially manioc, while there was a serious deficit of other crops especially chillies, etc. The situation would be improved if planters would not concentrate so exclusively on root crops.

In reply Major Oldfield pointed out that planters in many up-country areas had no option but to grow roots as rice, chillies, etc. could not be produced in their districts.

There was power under the Food Production Ordinance to regulate the crops that should be grown on estates. Nothing, however, had been done in this direction and the position was entirely unbalanced. Until distribution could be improved waste on a large scale would continue and he asked Mr. Seneviratne to take up the matter with the Marketing Commissioner. This Mr. Seniviratne agreed to do.

With regard to the proposed scheme of development of St. Coombs patna area Major Oldfield thought the matter should be referred back to the Estate and Experimental Sub-Committee. If the poonac position could not be cleared up alternative proposals should be made as it was most desirable something should be done, even if only on a small scale, to see how such land could be developed and ultimately made fit for food production.

The Board agreed to Major Oldfield's suggestion.

Major Oldfield left the meeting at this stage.

## 6. SENIOR STAFF

(6) *Acting Allowances.*—The Director tabled a statement showing the acting appointments held by different members of the staff since the beginning of the war due to other members of the staff being on service.

The Director mentioned that no acting allowances had been drawn by officers while so acting and, in view of the very different conditions now prevailing, as compared with the time (1939) when these arrangements were made, he thought the Board might wish to reconsider the position.

The Director referred, especially to the position of Dr. Gadd who, in addition to his acting appointments in the Biological Divisions, had extra responsibilities, in that he had to carry out certain of the routine duties of the Director when the latter was away from St. Coombs.

After discussion, it was decided that the Director should prepare a memorandum on the subject for the consideration of the Board at its next Meeting.

## 7. JUNIOR STAFF

*(i) Mr. P. R. Perera, Assistant to the Biochemist.*—The Board had been supplied with a medical report on the above officer

who had been on sick leave for 16 months. This report indicated that Mr. Perera would not be fit to resume his work with the Institute. The Board decided with regret to terminate Mr. Perera's appointment with effect from the 31st August, 1944, the date when the maximum period of sick leave earned would expire.

*(ii) Research Assistant to Agricultural Chemist.*—Reported that Mr. G. P. Enright who had been offered this appointment by the Board *(Vide* Circular of 18.2.44) had subsequently withdrawn his name. So far it had not been possible to find another suitable candidate and further enquiries were being made.

*(iii) Letter from Junior Staff Association dated 14th April, 1944, regarding grant of travelling expenses on one occasion per annum when proceeding on leave.*—The Director was instructed to inform the Junior Staff Association that the Board were unable to agree to their request.

### 8. JOINT RESEARCH ON THE CHEMISTRY OF TEA

Considered letter dated 6th March, 1944, from the Secretary, Ceylon Association in London, intimating that, as Dr. Lampitt was now no longer able to supervise this work and it was impracticable at present to make other supervisory arrangements, Dr. Bradfield's work had had tempo rarily to be suspended. Arrangements had, however, been made whereby Dr. Bradfield would resume his investigations as soon as the Indian Tea Association considered conditions permitted.

The Director said Dr. Bradfield's work had reached a stage where it began to link up with work at St. Coombs. So far investigations had been chiefly confined to the chemistry of made tea, but it was now realised by the Scientific Advisory Committee that work on the raw material was required. St. Coombs and Tocklai had always considered that this aspect of the work was of primary importance.

Dr. Norris said it would be unfortunate if a hiatus should now occur and suggested enquiries should be made as to the practicability of Dr. Bradfield working for a time at St. Coombs until arrangements could be made for a resumption of the work in England. This would enable him to apply his methods to green leaf and gain an insight into manufacturing conditions and the changes taking place during manufacture.

After discussion the Director was instructed to approach the Ceylon Association and ascertain the views of the Advisory Committee on his suggestion and whether, in the event of Dr. Bradfield being willing to come temporarily to Ceylon, the other Associations concerned would agree to maintain their contributions towards the cost of the investigations.

Dr. Norris intimated that he would also write to Dr. Lampitt thanking him for his services.

Mr. C. E. Jones and Mr. Mann left the meeting at this stage.

### 9. CEYLON ESTATES EMPLOYERS' FEDERATION

The Board decided that St. Coombs Estate should join the Federation and that the Director should be nominated at their representative, with power to give a proxy to the superintendent to vote on his behalf at any particular meeting if considered desirable.

### 10. DRAFT REPORT OF THE BOARD FOR 1943

The Draft Report of the Board was approved.

### 11. ANY OTHER BUSINESS

*(i) T. R. I. Car.*—The Director mentioned that the car had now done a very considerable mileage and cost of repairs and upkeep must be expected materially to increase. In this circumstance, if any favourable opportunity should occur, it would be advantageous to replace the car by a more recent model.

The Board agreed to this suggestion.

(ii) The Board agreed to pay arrears of Provident Fund amounting to Rs. 484.50 to Mr. T. D. J. M. Siriwardhane, formerly part-time Dispenser on St. Coombs, who left the Institute's service on 31st January, 1944.

The Meeting then concluded with a vote of thanks to the Chair.

ROLAND V. NORRIS,
*Secretary.*

# The Tea Research Institute of Ceylon.

## BOARD OF CONTROL

(A) Representing the Planters' Association of Ceylon:—

(1) Mr. R. G. Coombe.

(2) Mr. R. C. Scott.

(3) Mr. R. Singleton Salmon.

(B) Representing the Ceylon Estates Proprietary Association:—

(4) Major J. W. Oldfield, C.M.G., O.B.E., M.C.

(5) Mr. J. C. Kelly

(6) Mr. W. H. Gourlay

(C) Representing the Low-Country Products' Association:—

(7) Mr. W. P. H. Dias

(D) Representing the Small-Holders:—

(8) Adigar Sir T. B. Panabokke, (Chairman).

(E) Ex-Officio Members:—

(9) The Hon. the Financial Secretary

(10) The Director of Agriculture

(11) The Chairman, Planters' Association of Ceylon

(12) The Chairman, Ceylon Estates Proprietary Association

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Secretary, Roland V. Norris, D.Sc., St. Coombs, Talawakelle

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The publications of the Tea Research Institute will be sent, free of charge, to Superintendents of Ceylon tea estates, over 10 acres in extent, and to Estate Agencies dealing with Ceylon tea, if they register their names and addresses with *the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle.*

Other persons can obtain the publications of the Institute on application to the Director, the subscription being Rupees fifteen per annum for persons resident in Ceylon or India, and £1-5-0 for those resident elsewhere. Single numbers of *The Tea Quarterly* can be obtained for Rs. 2-50 or 4*s*. In the case of Indian cheques four annas should be added to cover commission.